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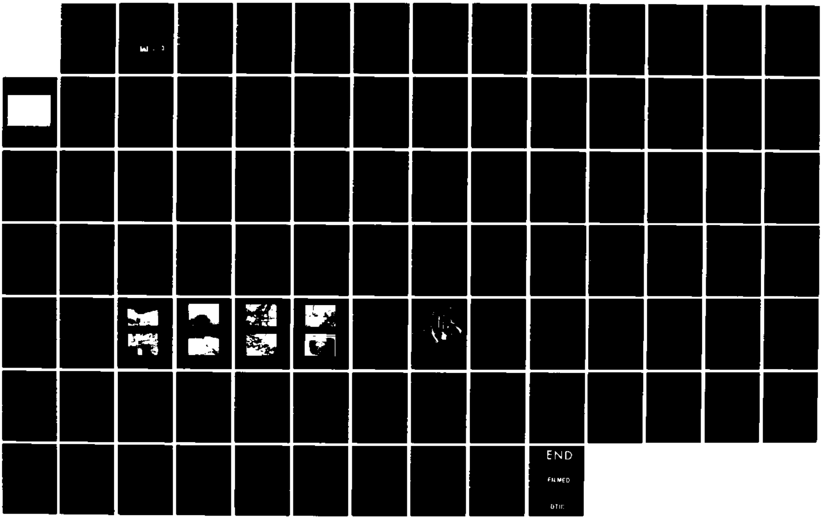

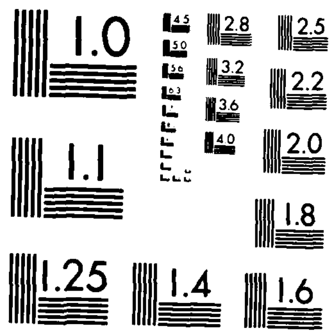
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AD-A155 996

COASTAL BASIN

ROCHESTER, NEW HAMPSHIRE

ROCHESTER RESERVOIR DAM

NH 00152

NHWRB NO. 204.13

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

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REPORT DOCUMENTATION PAGE

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5. TYPE OF REPORT & PERIOD COVERED: INSPECTION REPORT
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    Coastal Basin
    Rochester New Hampshire
    Howard Brook
20. ABSTRACT (Continue on reverse side if necessary and identify by block number):

THe dam is an earthen embankment dam and consists of two distinct sections. The maximu storage capacity at top of dam is about 790 acre ft.The dam is judged to be in poor condition with major concerns which must be implemented.It is small in size with a significant hazard potential.

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION. CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM. MASSACHUSETTS 02254

REPLY TO
ATTENTION OF:
NEDED

8 OCT 1980

Honorable Hugh J. Gallen
Governor of the State of New Hampshire
State House
Concord, New Hampshire 03301

Dear Governor Gallen:

Inclosed is a copy of the Rochester Reservoir Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Water Resources Board, the cooperating agency for the State of New Hampshire. In addition, a copy of the report has also been furnished the owner, City of Rochester, Rochester, New Hampshire.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Water Resources Board for your cooperation in carrying out this program.

Sincerely,

MAX B. SCHEIDER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

ROCHESTER RESERVOIR DAM
NH 00152
NHWRB 204.13

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COASTAL BASIN
ROCHESTER, NEW HAMPSHIRE

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION PROGRAM
PHASE I - INSPECTION REPORT
BRIEF ASSESSMENT

Identification No:	NH 00152
Name of Dam:	Rochester Reservoir Dam
Town:	Rochester
County and State:	Strafford, New Hampshire
Stream:	Howard Brook
Date of Inspection:	June 9, 1980

The Rochester Reservoir Dam is an earthen embankment dam and consists of two distinct sections. The left section of the dam extends from the left abutment to a natural knob which lies between the two channels in the valley downstream of the dam. The left section is about 213 feet long and about 26 feet high from toe of slope to crest of dam. The right section of the dam extends from the natural knob near the center of the valley to the right abutment. The right section is about 369 feet long and about 21 feet high from toe of slope to crest of dam. The overall length of the dam crest between abutments is about 668 feet including the natural knob near the center of the dam. Normally, no surface discharge occurs at the damsite, although there are two intake structures associated with the dam which feed water to the City of Rochester's water distribution system. A spillway structure is located at the opposite end of the reservoir.

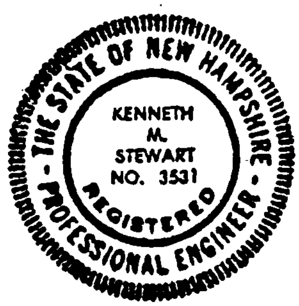
The dam is located at the east end of Rochester Reservoir at the headwaters of Howard Brook. There is a spillway at the west end of the reservoir which discharges outside the Howard Brook watershed to a swampy area immediately southwest of the reservoir and ultimately drains through Lond Pond to the Isinglass River in Barrington, New Hampshire. The dam was originally constructed and is still used to provide a water supply for the city of Rochester. The reservoir is 0.77 miles in length with a surface area of about 56 acres. The maximum storage capacity at top of dam is about 790 acre-feet.

As a result of the visual inspection of this facility, the dam is considered to be in POOR condition. Major concerns are: major active seepage at the downstream toe of the right section of the dam embankment; wet areas at several locations near the downstream toe of both sections of the dam embankment; water lines under continuous pressure beneath the left section of the dam embankment; stumps of recently cut large trees and their associated root systems on the crest of the dam embankment; extensive brush and small trees growing on the downstream slope of the dam embankment; minor erosion of the upstream slope of the dam embankment at the waterline; and inadequacy of the low-level outlets for dewatering the reservoir in an emergency.

The dam is classified as SMALL in size and a SIGNIFICANT hazard structure in accordance with the recommended guidelines established by the Corps of Engineers. The test flood for this dam, therefore, ranges from a 100-year flood to one-half the Probable Maximum Flood (1/2 PMF). Since the dam falls towards the upper end of the small size range for storage, the 1/2 PMF was utilized for this hydrologic analysis. The test flood inflow was estimated to be 530 cfs and resulted in a routed test flood outflow equal to 265 cfs which would not overtop the dam crest. The maximum spillway discharge capacity with the reservoir surface at the dam crest was estimated to be 465 cfs, which exceeds the routed test flood outflow. An assumed breach with the water surface at the dam crest would overtop Estes Road located about 1.3 miles below the dam by 6 to 8 feet and could damage two homes located near the point where Howard Brook passes beneath Estes Road. Water would rise to as much as one foot above the sill level of these homes. The potential for loss of less than a few lives as well as economic loss would exist.

It is recommended that the owner engage a qualified registered professional engineer to: investigate the active seepage and wet areas at the downstream toe of the dam; investigate the condition of the gate valves at the gate house and make them operable; specify and oversee procedures for the removal of trees, stumps and associated root systems from the dam embankment and a zone next to the downstream toe of the embankment; specify repairs for the minor erosion of the upstream slope of the dam embankment at the waterline; inspect the downstream slope of the dam embankment after brush and small trees have been cleared; and investigate the adequacy of the low-level outlets to drain the reservoir in an emergency. It is also recommended that the owner clear brush and small trees from the downstream slope of the dam and maintain the embankment free of brush, repair the gate house structure and replace the gate house door, and repair cracked and spalled concrete at the spillway.

The recommendations and remedial measures are described in Section 7 and should be addressed by the owner within one year after receipt of this Phase I Inspection Report, except for the investigation of the active seepage at the downstream toe of the dam which should be addressed immediately upon receipt of this report.



Kenneth M. Stewart

Kenneth M. Stewart
Project Manager
N.H.P.E. 3531

S E A Consultants Inc.
Rochester, New Hampshire

This Phase I Inspection Report on Rochester Reservoir Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

ARAMAST MAHTESIAN, MEMBER
Geotechnical Engineering Branch
Engineering Division

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

RICHARD DIBUONO, CHAIRMAN
Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and

rarity of such a storm event, finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

The Phase I investigation does not include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespassing and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

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APPENDICES

Major seepage is occurring at the downstream toe of the right section of the dam. This seepage could lead to internal erosion and breaching of the dam, if not controlled.

There are also several wet areas with no noticeable discharge of flowing water at the toe of both sections of the dam. These wet areas may be indicative of seepage problems which could eventually cause instability of the dam, if not corrected.

The inoperability of the gates in the gate house do not allow the 16-inch and 12-inch pipes which pass through the dam to be depressurized. Consequently, if a break were to occur in either of these pipes within the dam structure, the lines could not be shut off and internal erosion could compromise the structural integrity of the dam and lead to eventual failure.

Extensive brush and small trees growing on the downstream slope of the dam and in the zone downstream of the toe make it impossible to inspect those areas adequately. Also, if the trees grow to a large size, they could cause seepage and erosion problems if a tree blows over and pulls out its roots, or if a tree dies or is cut and its roots rot.

Several large trees have been recently cut on the crest of the dam, and seepage or erosion problems may develop as their roots rot.

Minor erosion is occurring on the upstream slope at the waterline and could eventually result in breaching of the embankment if it is not controlled.

The condition of the gate house does not allow it to be locked and, thereby, keep intruders out of the gate house. Continued exposure of the interior of the gate house to weather and to vandalism will only worsen the already poor condition of the gate house structure.

There is one area at the downstream toe of the right section of the dam where swamp grass is growing and one area near the downstream toe of the left section of the dam where ferns are growing. These types of vegetation indicate that the two areas are somewhat wetter than the surrounding areas.

Both abutments of the dam and the natural knob located near the center of the dam that separates the two sections of the dam consist of soil. There are many large boulders along both sides of the valley.

c. Appurtenant Structures. The principal intake structure gate house has been extensively vandalized. The door has been ripped off and much of the brickwork surrounding the doorway opening has been broken off (See Photo No. 3). The remainder of the brickwork and the portion of the stone masonry foundation which was visible above the reservoir surface appear to be in good condition. Wooden floor supports have rotted and given way and the right rear corner of the floor has sagged 6 to 8 inches. It appears that the primary structural item supporting the floor are cables running from the four corners of the floor inside the structure up to the roof. However, it was reported that the original purpose of these cables was to stabilize the present roof which was installed to replace the original roof structure which blew off some years ago. The gates located in the gate house appear to be inoperable. Consequently, the water lines which originate at this structure are controlled by a series of buried gate valves which are located about 100 feet downstream of the dam.

The secondary intake structure appears to be in fair to good condition (See Photo No. 9). The poured concrete structure is not excessively spalled and the gate valves are operable.

Located at the extreme west end of the reservoir is the principal spillway. There is a longitudinal crack in the concrete slab at the crest of the low-flow spillway and the left training wall is cracked and spalled (See Photo No. 16). The approach channel to the low-flow spillway is wide and unobstructed (See Photo No. 15). Brush and small trees are growing in the channel downstream of the spillway.

d. Reservoir Area. The slopes of the reservoir appear to be stable. No evidence of significant sedimentation was observed. The spillway for this reservoir discharges to a watershed which is separate from the area downstream of the dam.

e. Downstream Channel. There are two distinct channels downstream of the dam that are separated by a natural ridge in the central part of the valley. These channels join about 500 feet below the dam.

3.2 Evaluation

On the basis of the results of the visual inspection, Rochester Reservoir Dam is considered to be in poor condition.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. Rochester Reservoir Dam impounds a reservoir of small size. The drainage basin above the dam is small and consists of moderately sloped terrain surrounding the reservoir. The drainage basin is heavily wooded and almost completely undeveloped. The downstream area is predominantly undeveloped until Estes Road is reached.

The field inspection of Rochester Reservoir Dam was made on June 9, 1980. The inspection team consisted of personnel from S E A Consultants Inc. and Geotechnical Engineers, Inc. Inspection checklists, completed during the visual inspection, are included in Appendix A. At the time of inspection, no water was passing over the spillway. The pool elevation was at approximately 375 feet NGVD. The upstream face of the dam could only be inspected above this water level.

b. Dam. The Rochester Reservoir Dam is an earthen embankment dam and consists of two distinct sections. The left section is about 213 feet long and 26 feet high and extends from the left abutment to a natural knob which lies between the two channels in the valley downstream of the dam. The right section is about 369 feet long and 21 feet high and extends from the natural knob near the center of the valley to the right abutment.

The crest, upstream slope, and downstream slope of the dam are covered with cobbles embedded in soil (See Photo Nos. 7 and 8). It cannot be determined on the basis of the visual inspection alone whether these cobbles were placed as riprap or whether the entire cross section of the dam consists of a cobble-soil mixture.

The crest of the dam is somewhat irregular, but does not show evidence of major movements. Some brush and trees have been cut recently on the crest.

Brush and a few large trees have been cut recently on the upstream slope (See Photo No. 8). There has been minor erosion of the upstream slope at the waterline, but the cobbles are in place everywhere at and above the waterline, as mentioned above.

Extensive brush and small trees are growing on the downstream slope of both sections of the dam (See Photo Nos. 3 and 10). A considerable quantity of brush and some logs, apparently the brush and trees that were cut on the crest and upstream slope, have been dumped on the downstream slope near the crest.

Major active seepage is discharging at a rate of about 5 gpm near the downstream toe of the right section of the dam near the natural knob at the center of the valley (See Plans and Details in Appendix B and Photo Nos. 11 and 12). The discharging seepage water is clear. There is one wet area, with no noticeable discharge of flowing water, at the downstream toe of the right section of the dam near the right abutment.

SECTION 2
ENGINEERING DATA

2.1 Design

No design data were found for the Rochester Reservoir Dam.

2.2 Construction

No construction records were found.

2.3 Operation

No engineering operational data were found.

2.4 Evaluation

a. Availability. No engineering data were available for the Rochester Reservoir Dam. A search of the files of the New Hampshire Water Resources Board and direct contact with the owner revealed a limited amount of recorded information.

b. Adequacy. The lack of in-depth engineering data did not allow for a definitive review. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, past performance history and sound engineering judgment.

c. Validity. Two state inspection reports, one dated September 27, 1935 and the other not dated, but believed to be prior to 1950, refer to a concrete core. It was not possible to validate the existence of a concrete core. No other engineering data were found to validate.

(4) Control Mechanism

(a) 20-inch pipe - discharge through this line is controlled by closing the gate on the pipe leading into the intake structure

(b) 16-inch and 12-inch pipes - It appears that the gates at the gate house are not operable; however, these pipes can be controlled with buried gate valves that are located approximately 100 feet downstream of the dam. This series of valves also control the operation of the blowoff located at this point.

(5) Other

(a) A 6-inch diameter blowoff is located approximately 100 feet below the left section of the dam. The outlet invert of the blowoff is at an elevation of 345.5 feet. According to Rochester Public Works Department personnel, other blowoffs are located on all three water supply lines at various points between the reservoir and the city.

(b) A 6-inch diameter drain line outlets from the intake structure which is located at the right abutment and discharges at the toe of the dam. The inlet invert of this pipe is set at an elevation of 363.8 feet. Operation of this drain line is controlled by a gate valve located within the intake structure.

h. Diversion and Regulating Tunnel

Not applicable

i. Spillway

(1) Type - natural saddle in topography with a low-level spillway consisting of a concrete slab between low concrete training walls

(2) Length of weir - 19.5 feet (low-flow spillway)

(3) Crest elevation - 375.0 (low-flow spillway)
375.5 (natural saddle)

(4) Gates - N/A

(5) U/S Channel - The upstream channel consists of a natural stream channel bottom approximately 1.5 feet deep with dry stone masonry training walls. This channel extends about 25 feet from the reservoir to the concrete capped spillway. The entire spillway consists of a natural saddle in the topography surrounding the reservoir at which the low-flow spillway has been constructed.

(6) D/S Channel - The spillway discharges to a heavily overgrown swampy area immediately southwest of the reservoir and ultimately drains through Long Pond to the Isinglass River.

j. Regulating Outlets

(1) Invert - Water intake pipes to distribution system estimated by Rochester Public Works Department personnel to have maximum drawdowns of 10 feet and 20 feet below the normal water surface. This results in the following approximate inlet invert elevations.

(a) 20-inch pipe - 365±
(b) 16-inch pipe - 355±
(c) 12-inch pipe - 355±

(2) Size

(a) 20-inch pipe - inlet to intake structure at right abutment
(b) 16-inch pipe - at gate house
(c) 12-inch pipe - at gate house

(3) Description - Cast iron water intake pipes that feed water distribution system

e. Storage (acre-feet)

(1) Normal pool - 665

(2) Flood control pool - N/A

(3) Spillway crest pool - 665

(4) Top of dam - 790

(5) Test flood pool - 760

f. Reservoir Surface (acres)

(1) Normal pool - 56

(2) Flood control pool - N/A

(3) Spillway crest pool - 56

(4) Test flood pool - 67

(5) Top of dam - 70

g. Dam

(1) Type - earthen embankment, consisting of two distinct man-made sections

(2) Length - 582 feet (total man-made portion)
668 feet (between abutments)

(3) Height - 26 feet (left section)
21 feet (right section)

(4) Top Width - 12 feet (left section)
11 feet (right section)

(5) Side Slopes - left section, downstream 4V to 9H
right section, downstream 3V to 5H

(6) Zoning - unknown

(7) Impervious Core - unknown; two inspection reports refer to a concrete core

(8) Cutoff - unknown

(9) Grout curtain - none

(10) Other - none

(4) The capacity of the ungated spillway with the water surface at the test flood elevation (Elevation 376.6 feet) was estimated to be 265 cfs.

(5) Gated spillway capacity at normal pool elevation - N/A

(6) Gated spillway capacity at test flood elevation - N/A

(7) The total capacity of the spillway at the test flood elevation (Elevation 376.6 feet) was estimated to be 265 cfs.

(8) The total project discharge at the top of the dam (Elevation 377.0 feet) was estimated to be 465 cfs.

(9) The total project discharge at the test flood elevation (Elevation 376.6 feet) was estimated to be 265 cfs.

c. Elevation. (feet, NGVD) based on a pool elevation of 375.0 shown on U.S.G.S. quad sheet assumed to be the crest of the low-flow spillway.

(1) Streambed at toe of dam - 351

(2) Bottom of cutoff - unknown

(3) Maximum tailwater - unknown

(4) Normal pool - 375

(5) Full flood control pool - N/A

(6) Spillway crest - 375.0 (low-flow spillway)

(7) Design Surcharge (Original Design) - unknown

(8) Top of Dam - elevation varies - 377.0 (min.), 378.2 (max.)

(9) Test flood surcharge - 376.6

d. Reservoir (Length in feet)

(1) Normal pool - 4,060

(2) Flood control pool - N/A

(3) Spillway crest pool - 4,060

(4) Top of dam - 4,105

(5) Test flood pool - 4,095

1.3 Pertinent Data

a. Drainage Area. The drainage area above Rochester Reservoir Dam is small, covering only about 0.41 square miles (approximately 262 acres). There is evidence from a U.S.G.S. Quadrangle Sheet that a larger area, generally around Berrys River, once drained to the reservoir. However, at present, very little uncontrolled surface runoff flows directly to the reservoir from the vicinity of Berrys River due to the barrier created by New Hampshire Route 202A. A portion of the water flowing through Berrys River is intercepted and piped to the Rochester Reservoir, but this flow is controlled by a gate valve as described in section 1.2 b.

The topography in the drainage basin consists of moderately sloped terrain surrounding the Rochester Reservoir. The area is heavily wooded and almost completely undeveloped. The development which does exist consists of three or four houses that are located on the fringe of the basin along New Hampshire Route 202A.

b. Discharge at Damsite. Normally, there is no surface discharge from the damsite. However, discharge does occur through a series of pipes which feed the city of Rochester's water distribution system. One 16-inch diameter pipe and one 12-inch diameter pipe outlet from the gate house located about 70 feet from the left abutment. Based on information provided by the Rochester Public Works Department, it appears that the inlet inverts of these pipes are set at an elevation of about 355 feet (NGVD). These pipes are cross-connected about 100 feet below the dam, and a series of buried gate valves located at this point control the flow through these water supply lines as well as the operation of a 6-inch diameter blowoff which can be used to flush sediment from either pipe. The invert of the blowoff is set at an elevation of 345.5 feet (NGVD). A 20-inch diameter pipe which also feeds the city of Rochester's water distribution system outlets from a secondary intake structure which is located at the right abutment. Flow into the secondary intake structure is controlled by a valve on the 20-inch diameter inlet pipe on the upstream side of this structure. Based on information provided by the Rochester Public Works Department, it appears that the inlet invert of this 20-inch diameter pipe is set at an elevation of about 365 feet (NGVD). A 6-inch diameter drain which can be used to flush sediment from the intake structure also outlets from this intake structure and discharges at the toe of the dam. A valve which controls the operation of this drain is located within the intake structure. Surface discharge will occur over the spillway located at the extreme west end of the reservoir when the water surface rises above 375 feet (NGVD).

(1) The capacities of the blowoff located below the gate house and the drain pipe located at the right abutment were estimated to be 5 cfs and 3 cfs, respectively, with the water surface at the top of dam (Elevation 377.0 feet).

(2) Maximum known flood at damsite - unknown.

(3) The capacity of the ungated spillway with the water surface at the top of the dam (Elevation 377.0 feet) was estimated to be 465 cfs.

diameter pipe from Berrys River passes under the state highway and is controlled by a gate valve in the other manhole. These pipes connect between the manholes and a single 24-inch diameter pipe passes through a gate house and discharges at a concrete walled sluiceway (See Photo No. 14). This sluiceway, which discharges into the reservoir beneath a boat house, formerly contained bar racks to prevent leaves and twigs from entering the reservoir, but the bar racks are no longer in place.

c. Size Classification. Small (height - 26 feet; storage - 790 acre-feet) based on either height (greater than or equal to 25 feet and less than 40 feet) or storage (greater than or equal to 50 acre-feet and less than 1000 acre-feet) as given in the Recommended Guidelines for Safety Inspection of Dams.

d. Hazard Classification. Significant Hazard. An assumed breach in the Rochester Reservoir Dam would increase the stage along the stream channel near the Estes Road culvert by about 15 feet. The roadway would be overtopped by 6 to 8 feet and water would rise to as much as one foot above the sill of two houses located near the culvert. Beyond Estes Road the stream channel broadens to a wide swampy area before reaching the New Hampshire Route 202 culvert. The stage would quickly be reduced to about 7 to 8 feet through this section of the channel, so that houses located on the periphery of the swampy area and the state highway culvert would not be impacted. The potential for loss of less than a few lives as well as economic loss would exist. Failure of the dam would also result in loss of the city's water supply, since the pipes feeding the entire distribution system originate at the Rochester Reservoir.

e. Ownership. The dam has been continually owned by the city of Rochester, City Hall, Rochester, New Hampshire 03867, Telephone: (603) 332-1167 since it was constructed in the late 1800's.

f. Operator. The dam is maintained and operated by the Rochester Public Works Department, Water Division, 45 Old Dover Road, Rochester, New Hampshire 03867, Telephone: (603) 332-4096.

g. Purpose of Dam. The dam was originally constructed to provide the primary water supply for the city of Rochester and it still serves that purpose.

h. Design and Construction History. No information regarding the original design or construction of the dam was found. It is believed that the dam was constructed in the late 1800's.

i. Normal Operating Procedure. All the valves on pipes near the dam discharging to the city's water distribution system are normally open. These valves are adjusted to flush sediment from the lines through the blowoffs on an as-needed basis. All the valves on pipes near the spillway that control the flow into Rochester Reservoir from auxiliary storage reservoirs are normally open. These valves are adjusted based on daily visual observation to control the level of Rochester Reservoir at or just below the spillway crest (375.0 feet NGVD).

b. Description of Dam and Appurtenances. The Rochester Reservoir Dam is an earthen embankment dam and consists of two distinct sections (See Plans and Details in Appendix B). The left section of the dam extends from the left abutment to a natural knob which lies between the two channels in the valley downstream of the dam. The left section is about 12 feet wide at the crest, 213 feet long and about 26 feet high from toe of slope to crest of dam with a downstream slope of approximately 4 feet vertical to 9 feet horizontal (4:9). the right section of the dam extends from the natural knob near the center of the valley to the right abutment. The right section is about 11 feet wide at the crest, 369 feet long and about 21 feet high from toe of slope to crest of dam with a downstream slope of approximately 3 feet vertical to 5 feet horizontal (3:5). The overall length of the dam crest between abutments is about 668 feet including the natural knob near the center of the dam.

Located in the reservoir at a point approximately 70 feet from the left abutment and about 12 feet from the upstream crest of the dam is the principal intake structure which consists of a gate house which inlets water from the reservoir into one 16-inch diameter pipe and one 12-inch diameter pipe. Based on information provided by the Rochester Public Works Department, it appears that the approximate invert elevation of these two pipes is 355 feet (NGVD). The valves located in the gate house, and intended to control the inlets to these pipes, appear to be inoperable. These pipes pass through the dam and feed the city of Rochester's water distribution system. At a point approximately 100 feet downstream of the dam crest, these pipes are cross-connected and buried gate valves control the flow through these water supply lines as well as the operation of a 6-inch diameter blowoff which can be used to flush sediment from either line.

Located in the crest of the dam at the right abutment is the secondary intake structure (See Photo No. 9) which consists of a below grade, poured concrete chamber which inlets water from the reservoir into a 20-inch diameter pipe. This pipe passes through the dam and feeds the city of Rochester's water distribution system. Flow into the secondary intake structure is controlled by a valve on the 20-inch diameter inlet pipe on the upstream side of the structure. Based on information provided by the Rochester Public Works Department, it appears that the approximate invert elevation of this inlet pipe is 365 feet (NGVD). A 6-inch diameter drain which can be used to flush sediment from the chamber also passes through the dam and discharges near the toe of the dam. A valve which controls the operation of this drain is located within the concrete chamber.

Located at the extreme west end of the reservoir is the principal spillway which consists of a natural saddle in the topography surrounding the reservoir at which a concrete slab low-flow spillway approximately 20 feet long between 6-inch high concrete training walls has been constructed. Since the low-flow spillway appears to have been constructed at a natural saddle, the area adjacent to the low-flow spillway is not considered to be a dike.

Located approximately 225 feet to the right of the low-flow spillway are gate valves that control the flow into Rochester Reservoir from auxiliary storage reservoirs. A 20-inch diameter pipe from Round Pond passes under the spillway and is controlled by a gate valve in the manhole nearest to the spillway. A 20-inch

NATIONAL DAM INSPECTION
PHASE I INSPECTION REPORT
ROCHESTER RESERVOIR DAM

SECTION 1
PROJECT INFORMATION

1.1 General

a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsiblility of supervising the inspection of dams within the New England Region. S E A Consultants Inc. has been retained by the New England Division to inspect and report on selected dams in the state of New Hampshire. Authorization and notice to proceed were issued to S E A Consultants Inc. under a letter of November 5, 1979 from William Hodgson, Jr., Colonel, Corps of Engineers. Contract no. DACW33-80-C0008 has been assigned by the Corps of Engineers for this work.

b. Purpose

(1) To perform technical inspection and evaluation of non-federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-federal interests.

(2) To encourage and prepare the states to initiate quickly effective dam safety programs for non-federal dams.

(3) To update, verify and complete the National Inventory of Dams.

1.2 Description of Project

a. Location. The Rochester Reservoir is located on the corporate boundary line between Rochester and Barrington, New Hampshire at the headwaters of Howard Brook. The Rochester Reservoir Dam is located in Rochester, New Hampshire at the east end of the reservoir. There is no spillway at the dam, but any discharge emanating from the dam's low level outlets would flow in an easterly direction through Howard Brook and then Axe Handle Brook approximately 3.6 miles to its confluence with the Cocheco River in Rochester, New Hampshire. There is a spillway at the west end of the reservoir which discharges outside the Howard Brook watershed to a swampy area immediately southwest of the reservoir and ultimately drains through Long Pond to the Isinglass River in Barrington, New Hampshire. The dam is shown on U.S.G.S. Quadrangle, Alton, New Hampshire with coordinates approximately at N43°17'19", W71°02'35", Strafford County, New Hampshire (See Location Plan).

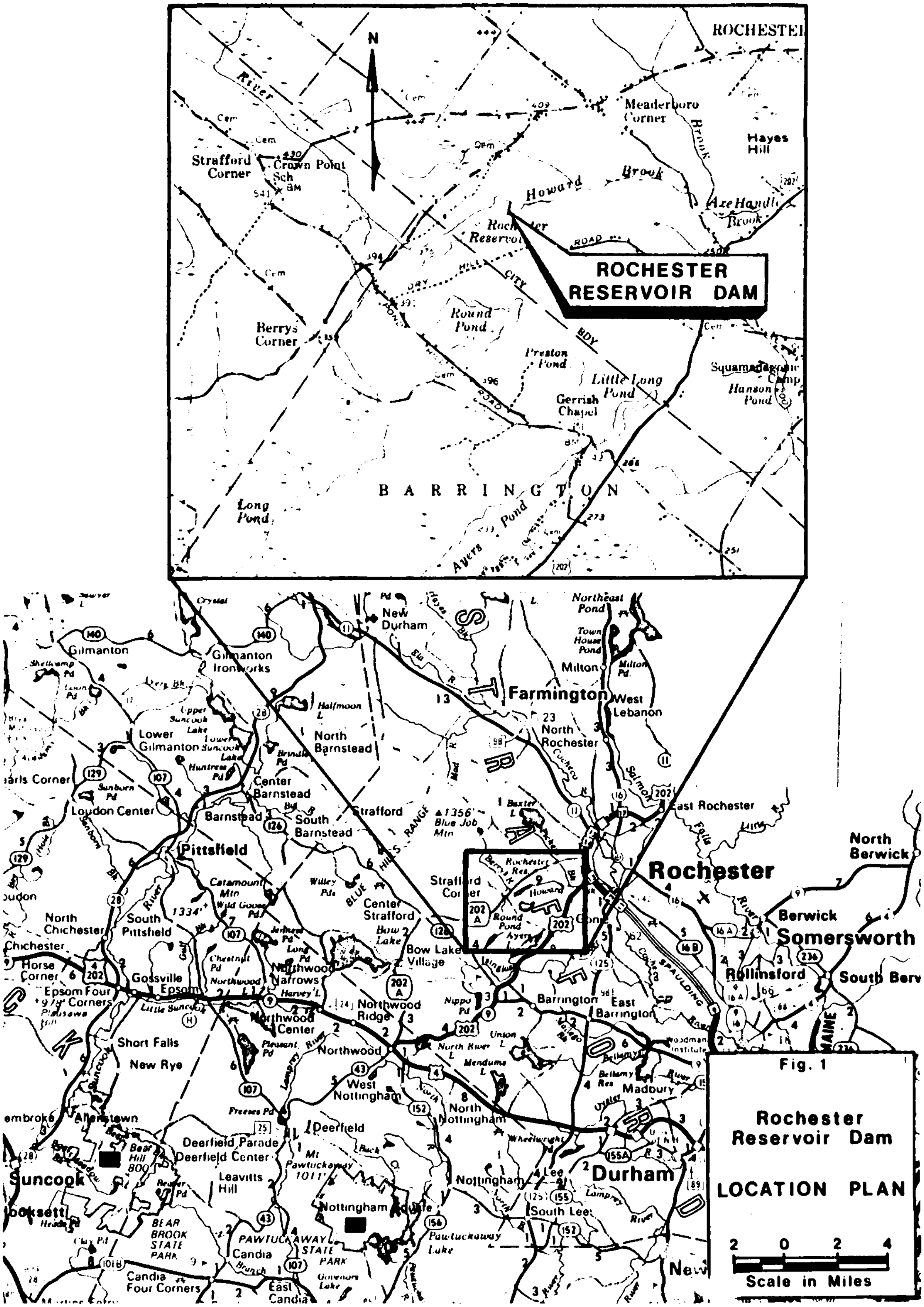


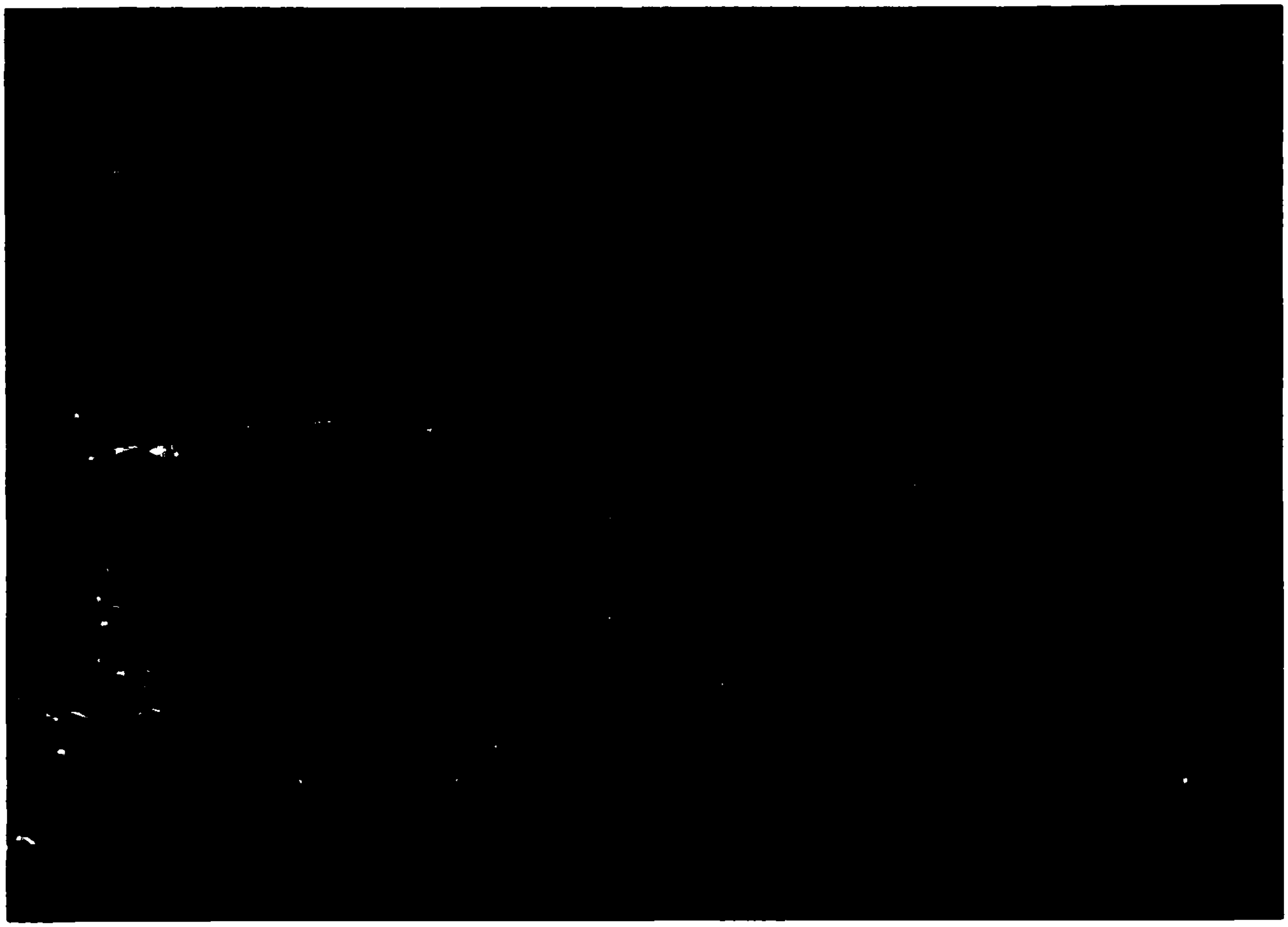
Fig. 1

Rochester Reservoir Dam

LOCATION PLAN

2 0 2 4

Scale in Miles



OVERVIEW PHOTO - ROCHESTER RESERVOIR DAM

SECTION 4
OPERATIONAL AND MAINTENANCE PROCEDURES

4.1 Operational Procedures

a. General. The Rochester Reservoir Dam is used for the retention of the Rochester Reservoir which is the primary water supply for the city of Rochester. There are no written operational procedures governing the operating facilities of this dam.

b. Description of Any Warning Systems in Effect. No written warning system exists for the dam.

4.2 Maintenance Procedures

a. General. The owner; the city of Rochester acting through its Department of Public Works, is responsible for the maintenance of the dam. No formal or written maintenance plan exists. However, the dam is visited frequently and it is reported that maintenance is performed on an as-needed basis.

b. Operating Facilities. No formal plan for maintenance of operating facilities exists.

4.3 Evaluation

The current operation and maintenance procedures for the Rochester Reservoir Dam are inadequate to ensure that all problems encountered can be remedied within a reasonable period of time. The owner should establish a written operation and maintenance procedure, as well as a warning system to follow in event of flood flow conditions or imminent dam failure.

SECTION 5
EVALUATION OF HYDROLOGIC/HYDRAULIC FEATURES

5.1 General. The Rochester Reservoir Dam is an earthen embankment dam and consists of two distinct sections. The left section of the dam extends from the left abutment to a natural knob which lies between the two channels in the valley downstream of the dam. The left section is about 213 feet long and about 26 feet high from toe of slope to crest of dam. The right section of the dam extends from the natural knob near the center of the valley to the right abutment. The right section is about 369 feet long and about 21 feet high from toe of slope to crest of dam. The overall length of the dam crest between abutments is about 668 feet including the natural knob near the center of the dam. Normally, no surface discharge occurs at the damsite, although there are two intake structures associated with the dam which feed water to the city of Rochester's water distribution system. A spillway that consists of a natural saddle in the topography surrounding the reservoir at which a concrete slab low-flow spillway has been constructed is located at the opposite end of the reservoir. The crest of the low-flow spillway is set at an elevation of 375 feet (NGVD).

The drainage area contributing surface runoff to the reservoir is quite small, about 0.41 square miles. Water discharging from the reservoir to the city's distribution system is replenished by water which is piped to the reservoir from Round Pond and Berrys River. The dam impounding the Rochester Reservoir is classified as small in size and has a maximum storage capactiy of 790 acre-feet.

5.2 Design Data. No hydrological or hydraulic design data were disclosed.

5.3 Experience Data. No experience data were disclosed. Maximum flood flows or elevations are unknown.

5.4 Test Flood Analysis. Due to the absence of detailed design and operational information, the hydrologic evaluation was performed utilizing data gathered during field inspection, watershed size and an estimated test flood determined from the Corps of Engineers guide curves. For this dam (small size and significant hazard), the test flood ranges from the 100-year flood to one-half the Probable Maximum Flood (1/2 PMF). Since the dam falls towards the upper end of the small size range for storage, the 1/2 PMF was utilized for this hydrologic analysis. The drainage area consists of moderately sloping terrain, so the "rolling" curve, from the Corps of Engineers set of guide curves, was used to estimate the maximum probable flood peak flow rate.

Based on an estimated maximum probable flood peak flow rate of 2,600 cfs per square mile and a drainage area of 0.41 square miles, the test flood inflow was estimated to be 530 cfs. The test flood was routed through the reservoir in accordance with the Corps of Engineers procedure for Estimating Effect of Surcharge Storage on Maximum Probable Discharge. The reservoir water surface was assumed to be at elevation 375.0 prior to the flood routing. The routed test flood outflow was estimated to be 265 cfs. This analysis indicated that the dam crest would not be overtopped. The test flood surcharge would reach an elevation of 376.6 feet (NGVD) and leave a freeboard of 0.4 feet below the minimum elevation of the top of dam. The capacity of the spillway with the reservoir surface at the dam crest was estimated to be 465 cfs, which exeeds the routed test flood outflow.

5.5 Dam Failure Analysis. The impact of dam failure was assessed utilizing the "Rule of Thumb" Guidance for Estimating Downstream Dam Failure Hydrographs published by the Corps of Engineers. The analysis covered a reach extending approximately 2 miles downstream to New Hampshire Route 202. There is no prefailure flow from the dam, so prefailure tailwater conditions were not considered in the calculations and the dam failure analysis was conducted with the water surface at the dam crest. Based on this analysis, Rochester Reservoir Dam has been classified as a significant hazard.

Due to the major seepage in the right section of the dam, it was determined that this section of the dam represented the most probable place for an assumed breach to occur. Consequently, a total of 117 feet of the right section of the dam (approximately 40 percent of the length at mid-height) was breached with a failure height of about 21 feet. The peak failure discharge was estimated to be 18,900 cfs.

The first 1.3 miles of the channel below the dam is completely undeveloped. However, a few houses are located near the point where Howard Brook passes beneath Estes Road. It appears that two of these houses may be impacted by the failure discharge which would increase the stage along this section of the stream by about 15 feet. Water would flow about 6 to 8 feet deep over Estes Road and would rise to as much as one foot above the sill level of two houses. As the channel passes beyond Estes Road and approaches New Hampshire Route 202, it broadens into a wide swampy area. Consequently, the stage would be reduced quickly to about 7 to 8 feet before it reaches the state highway. It appears that houses located on the periphery of the swampy area and the New Hampshire Route 202 culvert would not be impacted. The potential for the loss of less than a few lives as well as economic loss would exist. Failure of the dam would also result in loss of the city's water supply, since the pipes feeding the entire distribution system originate at the Rochester Reservoir.

SECTION 6
EVALUATION OF STRUCTURAL STABILITY

6.1 Visual Observations

The visual inspection indicates the following potential structural problems:

(1) Major active seepage at the downstream toe of the right section of the dam embankment, which could lead to internal erosion and breaching of the dam if not controlled.

(2) Wet areas with no noticeable discharge of flowing water at several locations near the downstream toe of both sections of the dam embankment, which may be indicative of seepage problems that could eventually cause instability of the dam if not controlled.

(3) Two water lines are under continuous pressure beneath the left section of the dam embankment. A break in either of these lines beneath the embankment could cause uncontrolled internal erosion of the dam.

(4) Stumps and root systems of large trees which have recently been cut on the crest of the dam embankment and which could lead to seepage and erosion problems as the roots rot.

(5) Brush and small trees growing on the downstream slope of the dam embankment which, if allowed to grow to large size, could cause seepage and erosion problems if a tree blows over and pulls out its roots, or if a tree dies or is cut and its roots rot.

(6) Minor erosion of the upstream slope of the dam embankment at the waterline which could eventually result in breaching of the dam.

(7) The floor of the gate house is in very poor condition and could easily collapse. This not only presents a safety hazard for operating personnel but would probably effect the operation of the valves located within the gate house.

6.2 Design and Construction Data

No information regarding the original design or construction of the dam was found, although it is believed that the dam was constructed in the late 1800's.

6.3 Post-Construction Changes

There is no record of changes since the construction of the dam.

6.4 Seismic Stability

The dam is located in Seismic Zone 2 and, in accordance with the Phase I guidelines, does not warrant seismic analysis.

SECTION 7
ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. The visual examination indicates that Rochester Reservoir Dam is in poor condition. The major concerns with respect to the integrity of the dam are:

(1) Major active seepage at the downstream toe of the right section of the dam embankment.

(2) Wet areas with no noticeable discharge of flowing water at several locations near the downstream toe of both sections of the dam embankment.

(3) Water lines under continuous pressure beneath the left section of the dam embankment.

(4) Stumps of recently cut large trees and their associated root systems on the crest of the dam embankment.

(5) Brush and small trees growing on the downstream slope of the dam embankment.

(6) Minor erosion of the upstream slope of the dam embankment at the waterline.

(7) Inadequate capacity of the low level outlets to drain the reservoir in an emergency.

b. Adequacy of Information. A dense cover of brush and small trees and some brush and logs which have been cut and dumped on the downstream slope cover most of the downstream slope of the dam and make it impossible to inspect the slope adequately. The information that is available from the visual inspection is adequate to identify the problems mentioned in 7.2. These problems will require the attention of a registered professional engineer qualified in the design and construction of dams who will have to make additional engineering studies to design or specify remedial measures. No additional information is needed for this Phase I investigation.

c. Urgency. The owner should implement the recommendations in 7.2 and 7.3 within one year after receipt of this Phase I report, except for the recommendation in 7.2 (1) which should be implemented immediately upon receipt of this report.

7.2 Recommendations

The owner should retain a registered professional engineer qualified in the design and construction of dams to:

(1) Investigate the active seepage at the downstream toe of the right section of the dam embankment and design remedial measures.

(2) Investigate the wet areas at several locations near the downstream toe of both sections of the dam embankment and design remedial measures, if needed.

(3) Investigate the condition of the gate valves at the gate house and make them operable.

(4) Specify and oversee procedures for the removal of trees, stumps. and associated roots systems from the dam embankment and a zone next to the downstream toe of the embankment and backfilling of resulting voids.

(5) Inspect the downstream slope of the dam embankment after brush and small trees have been cleared.

(6) Specify repairs for the minor erosion of the upstream slope of the dam embankment at the waterline.

(7) Investigate the adequacy of the low level outlets to drain the reservoir in an emergency and design remedial measures, if necessary.

The owner should carry out the recommendations made by the engineer.

7.3 Remedial Measures

a. Operating and Maintenance Procedures. The owner should:

(1) Clear brush from the downstream slope of the dam and maintain the embankment free of brush.

(2) Repair the gate house structure and replace the gate house door in order to keep non-authorized personnel out.

(3) Repair cracked and spalled concrete at the spillway and maintain the spillway area free of brush.

(4) Visually inspect the dam and appurtenant structures once a month.

(5) Establish written maintenance and operating procedures.

(6) Engage a registered professional engineer qualified in the design and construction of dams to make a comprehensive technical inspection of the dam once every year.

(7) Establish a surveillance program for use during and immediately after periods of heavy rainfall, and also a warning program to follow in case of emergency conditions.

7.4 Alternatives

There are no practical alternatives to the recommendations of Section 7.2 and 7.3

APPENDIX A

INSPECTION CHECKLIST

INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT: Rochester Reservoir Dam, NH

DATE: June 9, 1980

TIME: 1:30 p.m.

WEATHER: Sunny, cool

W.S. ELEV. 375.0 (NGVD) U.S. N/A DN.S.

PARTY:

1.	Kenneth Stewart, S E A	6.	Richard DeBold, NHWRB
2.	Bruce Pierstorff, S E A	7.	Mr. Turcotte, Rochester, W.W.
3.	Robert Durfee, S E A	8.	
4.	Philip Upton, S E A	9.	
5.	Ronald Hirschfeld, GEI	10.	

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	Structural Stability	K. Stewart/R. Durfee	
2.	Hydrology/Hydraulics	B. Pierstorff	
3.	Soils and Geology	R. Hirschfeld	
4.			
5.			
6.			
7.			
8.			
9.			
10.			

INSPECTION CHECK LIST

PROJECT: Rochester Reservoir Dam, NH DATE: June 9, 1980

PROJECT FEATURE: Dam Embankment NAME:

DISCIPLINE: NAME:

AREA EVALUATED	CONDITIONS
DAM EMBANKMENT	
Crest Elevation	377.0
Current Pool Elevation	375.0
Maximum Impoundment to Date	Unknown
Surface Cracks	None observed
Pavement Condition	Not paved
Movement or Settlement of Crest	Crest surface is somewhat irregular
Lateral Movement	None observed
Vertical Alignment	See "Movement or Settlement of Crest"
Horizontal Alignment	Good
Condition at Abutment and at Concrete Structures	Good
Indications of Movement of Structural Items on Slopes	None observed
Trespassing on Slopes	Footpath along crest of dam; no evidence of trespassing on side slopes observed
Vegetation on Slopes	Brush and several large trees recently cut from crest and upstream slope. Brush on downstream slope.
Sloughing or Erosion of Slopes or Abutments	None observed
Rock Slope Protection - Riprap Failures	Crest, upstream slope, and downstream slope covered with cobbles which could have originally been placed as riprap
Unusual Movement or Cracking at or near Toe	None observed
Unusual Embankment or Downstream Seepage	Active seepage discharge in downstream face of right section of dam at STA 4+00
Piping or Boils	See "Unusual Embankment or Downstream Seepage"
Foundation Drainage Features	None observed
Toe Drains	None observed
Instrumentation System	None

INSPECTION CHECK LIST

PROJECT: Rochester Reservoir Dam, NH

DATE: June 9, 1980

PROJECT FEATURE: Dike Embankment

NAME:

DISCIPLINE:

NAME:

AREA EVALUATED	CONDITIONS
DIKE EMBANKMENT	No Dike
Crest Elevation	
Current Pool Elevation	
Maximum Impoundment to Date	
Surface Cracks	
Pavement Condition	
Movement or Settlement of Crest	
Lateral Movement	
Vertical Alignment	
Horizontal Alignment	
Condition at Abutment and at Concrete Structures	
Indications of Movement of Structural Items on Slopes	
Trespassing on Slopes	
Vegetation on Slopes	
Sloughing or Erosion of Slopes or Abutments	
Rock Slope Protection - Riprap Failures	
Unusual Movement or Cracking at or near Toes	
Unusual Embankment or Downstream Seepage	
Piping or Boils	
Foundation Drainage Features	
Toe Drains	
Instrumentation System	

INSPECTION CHECK LIST

PROJECT: Rochester Reservoir Dam, NH

DATE: June 9, 1980

PROJECT FEATURE: Intake Channel

NAME:

DISCIPLINE:

NAME:

AREA EVALUATED	CONDITIONS
<u>OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE</u>	
a. Approach Channel	
Slope Conditions	Good
Bottom Conditions	Not visible beneath reservoir surface
Rock Slides or Falls	None
Log Boom	None
Debris	None observed
Condition of Concrete Lining	Not visible beneath reservoir surface
Drains or Weep Holes	None
b. Intake Structure	Not visible beneath reservoir surface
Condition of Concrete	
Stop Logs and Slots	

INSPECTION CHECK LIST

PROJECT: Rochester Reservoir Dam, NH — DATE: June 9, 1980

PROJECT FEATURE: Control Tower — NAME: ______

DISCIPLINE: ______ — NAME: ______

AREA EVALUATED	CONDITIONS
<u>OUTLET WORKS - CONTROL TOWER</u>	Brick masonry gate house is control tower
a. Concrete and Structural	
General Condition	Poor
Condition of Joints	Good except where masonry has been vandalized
Spalling	N/A
Visible Reinforcing	N/A
Rusting or Staining of Concrete	N/A
Any Seepage or Efflorescence	None
Joint Alignment	Good
Unusual Seepage or Leaks in Gate Chamber	Not visible beneath reservoir surface
Cracks	Masonry extensively vandalized
Rusting or Corrosion of Steel	N/A
b. Mechanical and Electrical	
Air Vents	None
Float Wells	None
Crane Hoist	None
Elevator	None
Hydraulic System	None
Service Gates	Not visible
Emergency Gates	None
Lightning Protection System	None
Emergency Power System	None
Wiring and Lighting System	None

INSPECTION CHECK LIST

PROJECT: Rochester Reservoir Dam, NH	DATE: June 9, 1980
PROJECT FEATURE: Transition and Conduit	NAME:
DISCIPLINE:	NAME:

AREA EVALUATED	CONDITIONS
OUTLET WORKS - TRANSITION AND CONDUIT	Not visible beneath reservoir surface
General Condition of Concrete	
Rust or Staining on Concrete	
Spalling	
Erosion or Cavitation	
Cracking	
Alignment of Monoliths	
Alignment of Joints	
Numbering of Monoliths	

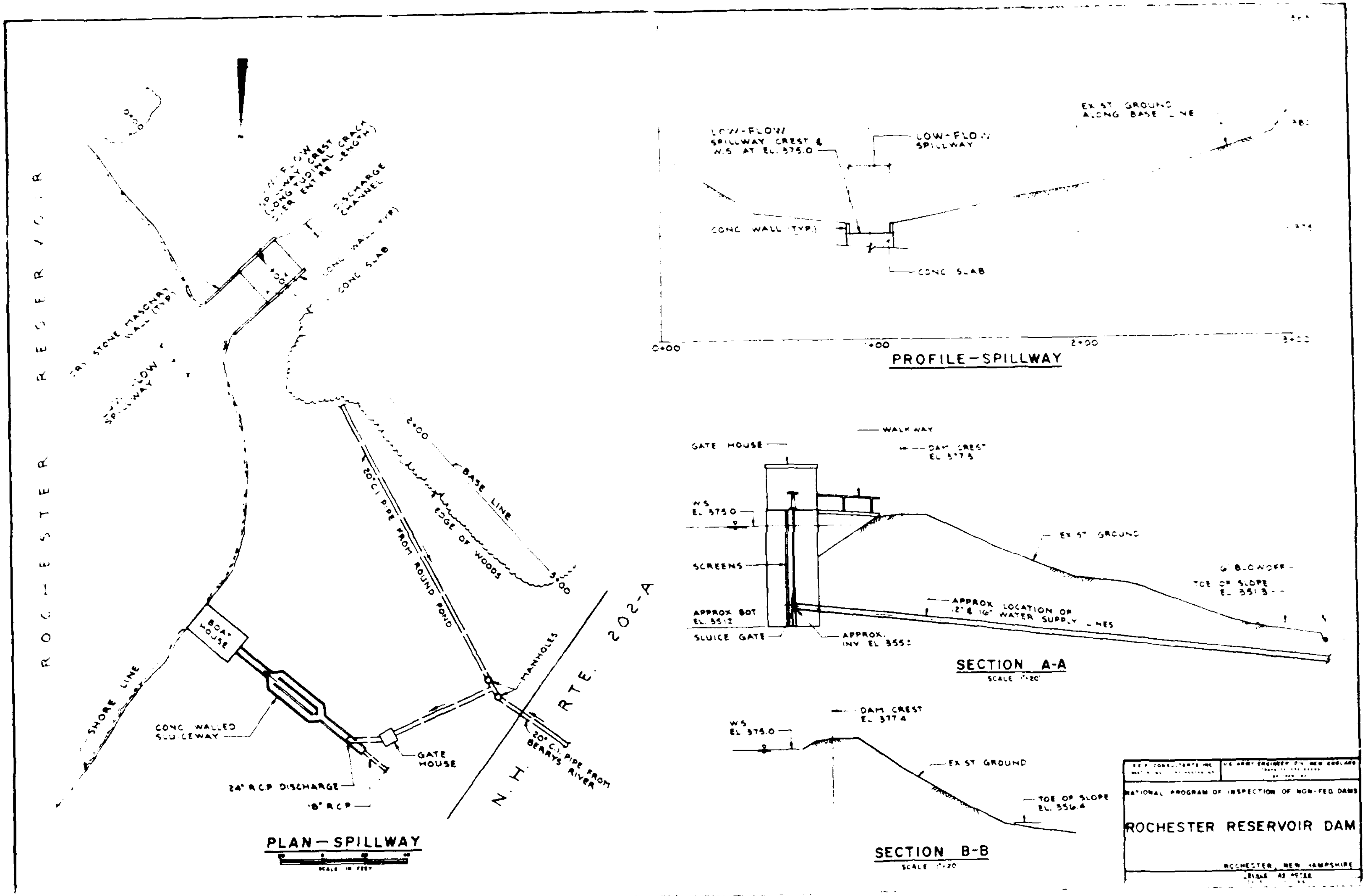
INSPECTION CHECK LIST

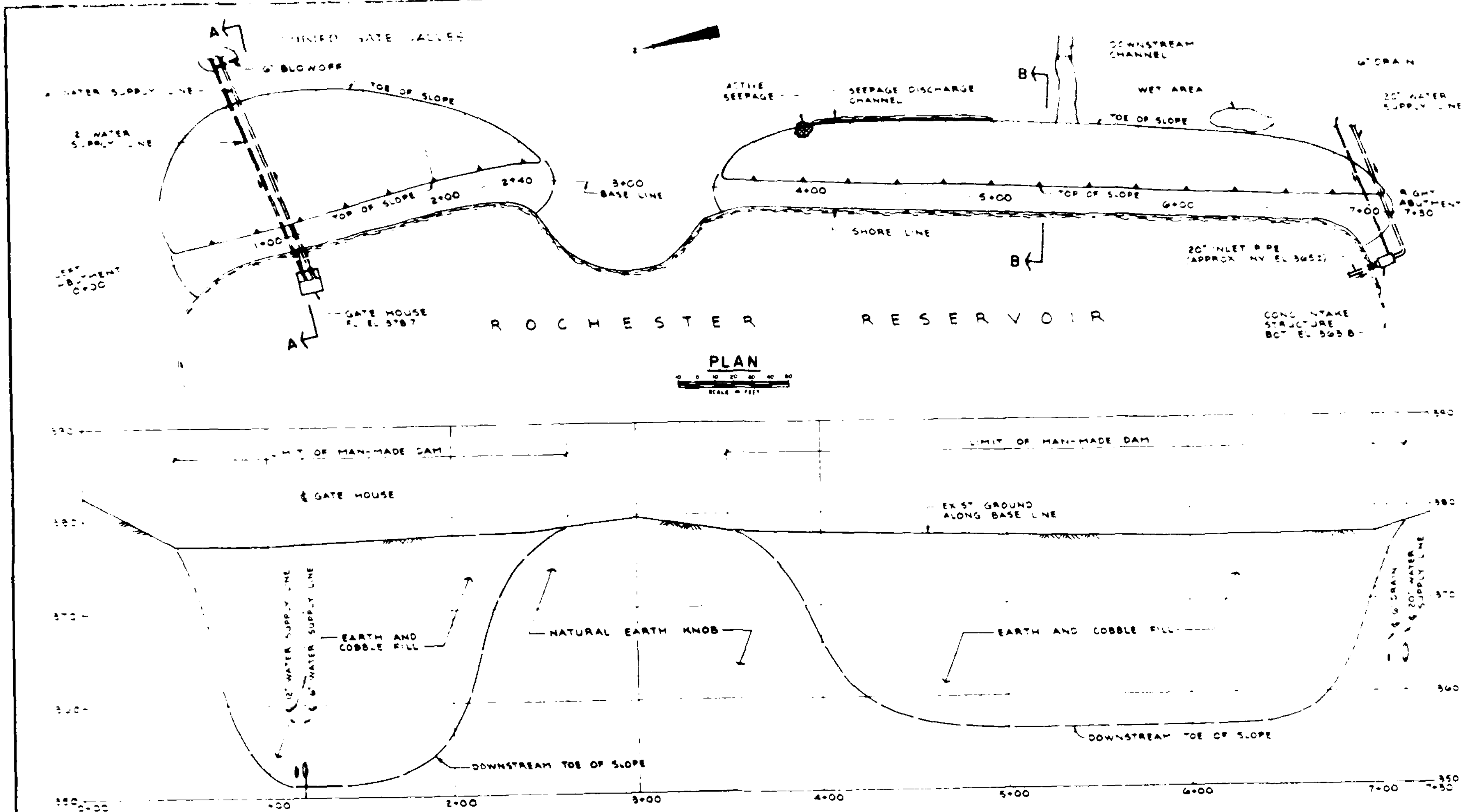
PROJECT: Rochester Reservoir Dam, NH | DATE: June 9, 1980

PROJECT FEATURE: Outlet Structure | NAME:

DISCIPLINE: | NAME:

AREA EVALUATED	CONDITIONS
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	Not visible-underground; outlet structure is city water system
General Condition of Concrete	
Rust or Staining	
Spalling	
Erosion or Cavitation	
Visible Reinforcing	
Any Seepage or Efflorescence	
Condition at Joints	
Drain holes	
Channel	
Loose Rock or Trees Overhanging Channel	
Condition of Discharge Channel	


ROCHESTER RESERVOIR
SHORE LINE
DRY STONE MASONRY WALL (TYP)
LOW-FLOW SPILLWAY
DISCHARGE CHANNEL
CONC WALL (TYP)
CONC SLAB
BOAT HOUSE
CONC WALLED SLUICEWAY
24" R.C.P. DISCHARGE
18" R.C.P.
GATE HOUSE
20" C.I. PIPE FROM ROUND POND
EDGE OF WOODS
BASE LINE
2+00
3+00
MANHOLES
N.H. RTE. 202-A
20" C.I. PIPE FROM BERRYS RIVER
PLAN—SPILLWAY
LOW-FLOW SPILLWAY CREST & W.S. AT EL. 375.0
LOW-FLOW SPILLWAY
EX ST GROUND ALONG BASE LINE
CONC WALL (TYP)
CONC SLAB
0+00
1+00
2+00
PROFILE—SPILLWAY
WALKWAY
GATE HOUSE
DAM CREST EL. 377.5
W.S. EL. 375.0
EX ST GROUND
SCREENS
6" BLOWOFF
TOE OF SLOPE EL. 351.3
APPROX BOT EL. 351.2
APPROX LOCATION OF 12" & 16" WATER SUPPLY LINES
SLUICE GATE
APPROX. INV EL. 355
SECTION A-A
SCALE 1"=20'
DAM CREST EL. 377.4
W.S. EL. 375.0
EX ST GROUND
TOE OF SLOPE EL. 356.4
SECTION B-B
SCALE 1"=20'
NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS
ROCHESTER RESERVOIR DAM
ROCHESTER, NEW HAMPSHIRE



PROFILE

NOTES

1) THE ELEVATIONS SHOWN ARE BASED ON AN ELEVATION OF 375 SHOWN ON U.S.G.S. QUADRANGLE SHEET ASSUMED TO BE POOL ELEVATION AT CREST OF SPILLWAY.

2) THE INFORMATION SHOWN ON THESE DRAWINGS ARE BASED ON THE EXISTING SKETCHES AND VISUAL OBSERVATIONS MADE DURING THE FIELD INSPECTION. DIMENSIONS OR MATERIALS INDICATED ON THESE DRAWINGS WHICH WERE BELOW GRADE OR WATER DURING THE TIME OF INSPECTION WERE NOT VERIFIED.

U.S. ARMY ENGINEER DIV. NEW ENGLAND

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

ROCHESTER RESERVOIR DAM

ROCHESTER, NEW HAMPSHIRE

PLANS AND DETAILS

Co.

CALCULATION SHEET

Date 9-27-35

Refers to

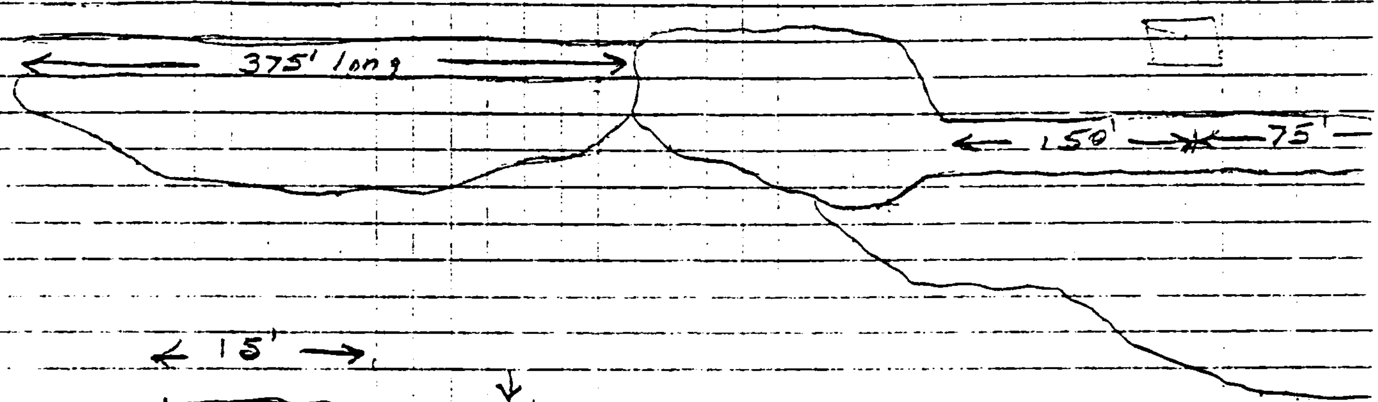
Made By

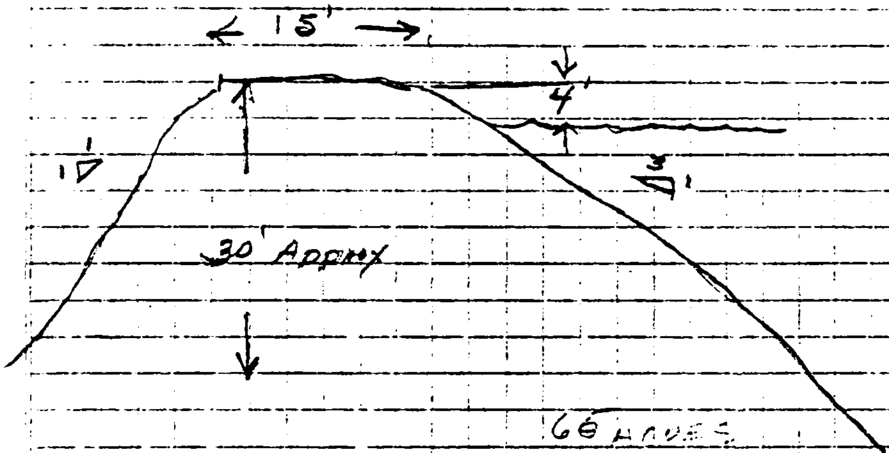
3646

- ROCHESTER WATER WORKS -
- RESERVOIR -

I-1?

Approx 30' high Concrete Core 35' HIGH





68 ACRES

Spillway at opposite end of reservoir from dam
19' long - 6" deep

NEW HAMPSHIRE WATER RESOURCES BOARD

INVENTORY OF DAMS AND WATER POWER DEVELOPMENTS

DAM

BASIN Ocean NO. 13 - 53 - I - 4325
RIVER Reservoir MILES FROM MOUTH ____ D.A.SQ.MI. ____
TOWN Rochester OWNER Rochester Water Works
LOCAL NAME OF DAM ____
BUILT ____ DESCRIPTION Gravity — Earth & Rock on Earth

POND AREA-ACRES 65 / 8 to ? DRAWDOWN FT. 4 ERS POND CAPACITY-ACRE FT. ____
HEIGHT-TOP TO BED OF STREAM-FT. 35 ± MAX. ____ MIN. ____
OVERALL LENGTH OF DAM-FT. 500 ± MAX.FLOOD HEIGHT ABOVE CREST-FT. ____
PERMANENT CREST ELEV.U.S.G.S. ____ LOCAL GAGE ____
TAILWATER ELEV.U.S.G.S. ____ LOCAL GAGE ____
SPILLWAY LENGTHS-FT. None FREEBOARD-FT. ____
FLASHBOARDS-TYPE, HEIGHT ABOVE CREST ____
WASTE GATES-NO. WIDTH MAX. OPENING DEPTH SILL BELOW CREST

REMARKS Condition good Spillway 10 ft long 4 ft below
Top at opposite end reservoir from
dam
into Howard Brook Pickers Bk. Cocheco R.

POWER DEVELOPMENT

UNITS	NO.	RATED HP	HEAD FEET	C.F.S. FULL GATE	KW	MAKE

USE Conservation Domestic

REMARKS Menace Water Supply

DATE 9/27/35

Form E1A

PUBLIC SERVICE COMMISSION OF NEW HAMPSHIRE—DAM RECORD I-4925

TOWN	Rochester	TOWN NO.	13	STATE NO.	204.13
RIVER STREAM	Rochester Reservoir				
DRAINAGE AREA	10.42 sq. mi.	POND AREA	65 Acres		
DAM TYPE	Gravity	FOUNDATION NATURE OF	Earth		
MATERIALS OF CONSTRUCTION	Earth, Rock				
PURPOSE OF DAM	POWER—CONSERVATION—DOMESTIC—RECREATION—TRANSPORTATION—PUBLIC UTILITY				
HEIGHTS, TOP OF DAM TO BED OF STREAM	Approx. 35'	TOP OF DAM TO SPILLWAY CRESTS	Approx. 4'		
SPILLWAYS, LENGTHS DEPTHS BELOW TOP OF DAM	19' 6"			LENGTH OF DAM	Approx. 500'
FLASHBOARDS TYPE, HEIGHT ABOVE CREST					
OPERATING HEAD CREST TO N. T. W.		TOP OF FLASHBOARDS TO N. T. W.			
WHEELS, NUMBER KINDS & H. P.					
GENERATORS, NUMBER KINDS & K. W.					
H. P. 90 P. C. TIME 100 P. C. EFF.		H. P. 75 P.C. TIME 100 P. C. EFF.			
REFERENCES, CASES, PLANS, INSPECTIONS.					
REMARKS					

OWNER- Rochester Water Works

CONDITION- Good

MENACE- Yes. Will be subject to periodic inspection.

To the Public Service Commission:

The foregoing memorandum on the above dam is submitted covering inspection made September 27, 1935, and bill for same is enclosed. Mr. George Dame was present at the inspection.

Samuel J. Lord
Hyd. Eng.

Nov. 25, 1935

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON DAMS IN NEW HAMPSHIRE

LOCATION STATE NO. 204.13

Town Rochester : County Strafford

Stream Reservoir

Basin-Primary Ocean : Secondary Cocheco

Local Name

Coordinates—Lat. 43° 15' + 13200 : Long. 71° 0' + 11400

GENERAL DATA

Drainage area: Controlled Sq. Mi.: Uncontrolled Sq. Mi.: Total 10.42 Sq. Mi.

Overall length of dam 500 ft.: Date of Construction

Height: Stream bed to highest elev. 35 ft.: Max. Structure 31 ft.

Cost—Dam : Reservoir

DESCRIPTION Gravity earth and rock concrete core

Waste Gates

Type

Number : Size ft. high x ft. wide

Elevation Invert : Total Area sq. ft.

Hoist

Waste Gates Conduit

Number : Materials

Size ft.: Length ft.: Area sq. ft.

Embankment

Type

Height—Max. ft.: Min. ft.

Top—Width : Elev. ft.

Slopes—Upstream on : Downstream on

Length—Right of Spillway : Left of Spillway

Spillway

Materials of Construction 5" below top of opposite end reservoir (concrete)

Length—Total 19' ft.: Net ft.

Height of permanent section—Max. 31 ft.: Min. ft.

Flashboards—Type none : Height ft.

Elevation—Permanent Crest : Top of Flashboard

Flood Capacity cfs.: cfs/sq. mi.

Abutments

Materials:

Freeboard: Max. 4 ft.: Min. ft.

Headworks to Power Devel.—(See "Data on Power Development")

OWNER Rochester Water Works

REMARKS Condition good Water Supply
Subject to inspection Use conservation

Tabulation By C.S.W. Date

B&B21234

NEW HAMPSHIRE WATER CONTROL COMMISSION

REPORT ON DAM INSPECTION

TOWN Rochester DAM NO. [illegible] STREAM [illegible]

OWNER [illegible] ADDRESS Rochester [illegible]

In accordance with Section 20 of Chapter 133, Laws of 1937, the above dam was inspected by me on [illegible] ~~accompanied by~~

NOTES ON PHYSICAL CONDITION

Abutments Good

Spillway Good

Gates Operable

Other

CHANGES SINCE LAST INSPECTION No

FUTURE INSPECTIONS Yes

This dam (is) (~~is not~~) a menace because [illegible]

REMARKS

Copy to Owner	Date

[illegible signature]
INSPECTOR

(Additional Notes Over)

State of New Hampshire
WATER RESOURCES BOARD
37 Pleasant Street
Concord, N.H. 03301
TELEPHONE 271-3406

February 15, 1978

Mr. Paul Clement, City Engineer
Old Dover Road
Rochester, NH 03867

Dear Mr. Clement:

Under the provisions of RSA Chapter 482, Sections 8 through 15, copy enclosed, on December 2, 1977 an Engineer of the Water Resources Board inspected your dam in Rochester. This dam, #204.13, is classified in the files of this office as a menace structure and as such must be maintained in a manner not to endanger public safety nor become a dam is disrepair.

As a result of this inspection it was noted that items of maintenance or repair are in need of attention.

1. Trees and brush on the dam to be cut.

If you have any questions, please contact us at your convenience.

Very truly yours,

George M. McGee, Sr.
Chairman

GMMG:PK:njk

Enc.

PAST INSPECTION REPORTS

AVAILABLE ENGINEERING DATA

No Engineering Data other than past inspection reports from the State of New Hampshire Water Resource Board were available.

APPENDIX B

ENGINEERING DATA

INSPECTION CHECK LIST

PROJECT: Rochester Reservoir Dam, NH

DATE: June 9, 1980

PROJECT FEATURE: Service Bridge

NAME:

DISCIPLINE:

NAME:

AREA EVALUATED	CONDITIONS
OUTLET WORKS - SERVICE BRIDGE	Service bridge is temporary wooden structure to gate house
a. Super Structure	
Bearings	See "Bridge Seat"
Anchor Bolts	None
Bridge Seat	Gate house structure and dam embankment
Longitudinal Members	Wood beams - unpainted
Under Side of Deck	Wood - unpainted
Secondary Bracing	Wood beams - unpainted
Deck	Wood planking - unpainted
Drainage System	None
Railings	Wooden 2 x 4's - unpainted
Expansion Joints	None
Paint	Not painted
b. Abutment & Piers	
General Condition of Concrete	N/A
Alignment of Abutment	N/A
Approach to Bridge	Pathway on crest of dam
Condition of Seat & Backwall	N/A

INSPECTION CHECK LIST

PROJECT: Rochester Reservoir Dam, NH	DATE: June 9, 1980
PROJECT FEATURE: Spillway Weir	NAME:
DISCIPLINE:	NAME:

AREA EVALUATED	CONDITIONS
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	Spillway is located at opposite end of reservoir from dam.
a. Approach Channel	
General Condition	Good
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	None
Floor of Approach Channel	Sand, gravel, cobbles
b. Weir and Training Walls	
General Condition of Concrete	Fair
Rust or Staining	None observed
Spalling	Left training wall is cracked and spalled; longitudinal crack in concrete slab at spillway weir crest
Any Visible Reinforcing	None
Any Seepage or Efflorescence	None
Drain Holes	None
c. Discharge Channel	
General Condition	Poor
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	Trees overhang channel
Floor of Channel	Sand, gravel, cobbles
Other Obstructions	Brush and small trees growing in channel

APPENDIX C

SELECTED PHOTOGRAPHS

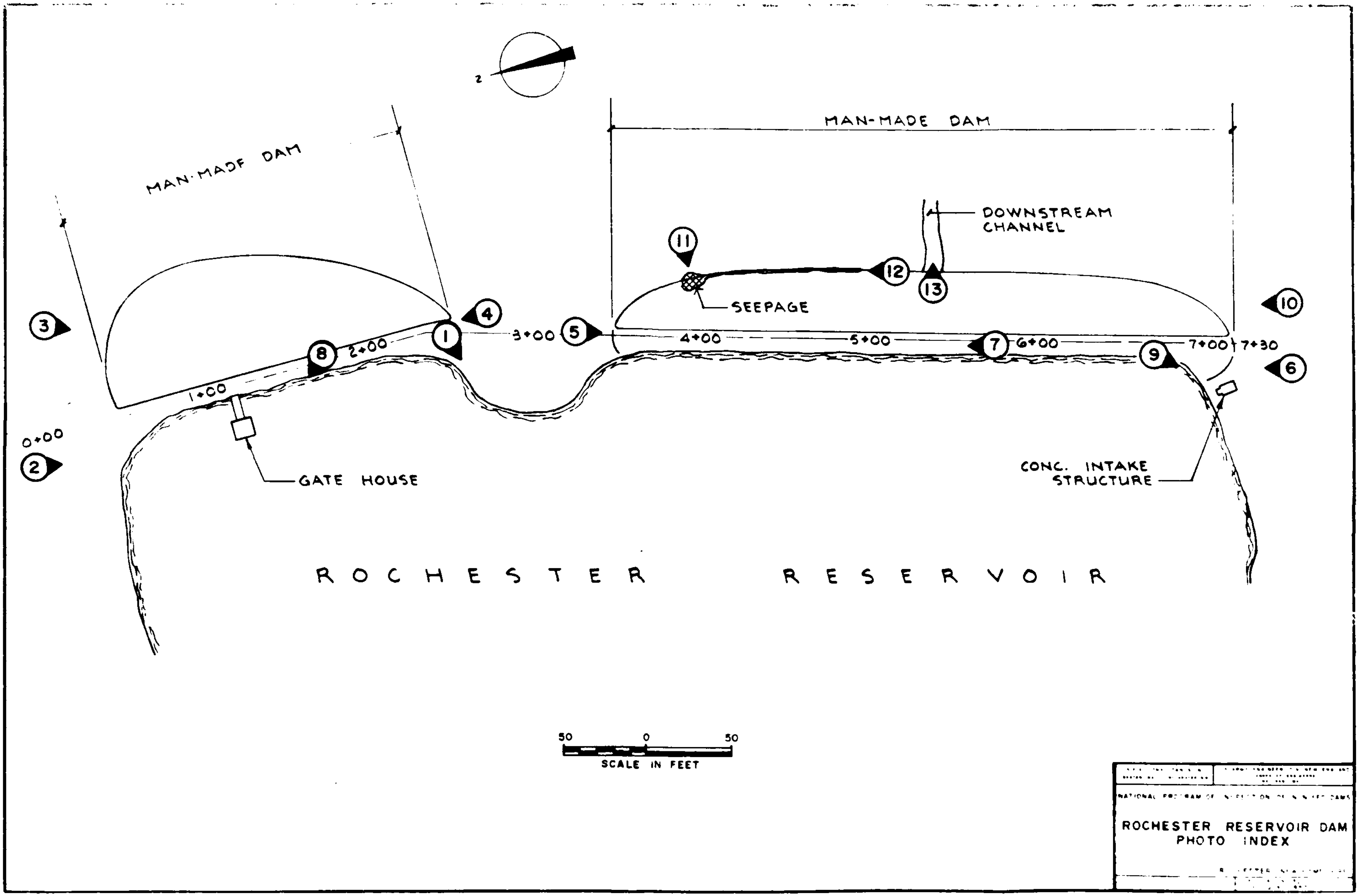

MAN-MADE DAM
MAN-MADE DAM
DOWNSTREAM CHANNEL
SEEPAGE
GATE HOUSE
CONC. INTAKE STRUCTURE
ROCHESTER RESERVOIR
0+00
1+00
2+00
3+00
4+00
5+00
6+00
7+00
7+30
1
2
3
4
5
6
7
8
9
10
11
12
13
N
50
0
50
SCALE IN FEET
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS
ROCHESTER RESERVOIR DAM
PHOTO INDEX

Photo No. 1 - General view of reservoir from center of dam.

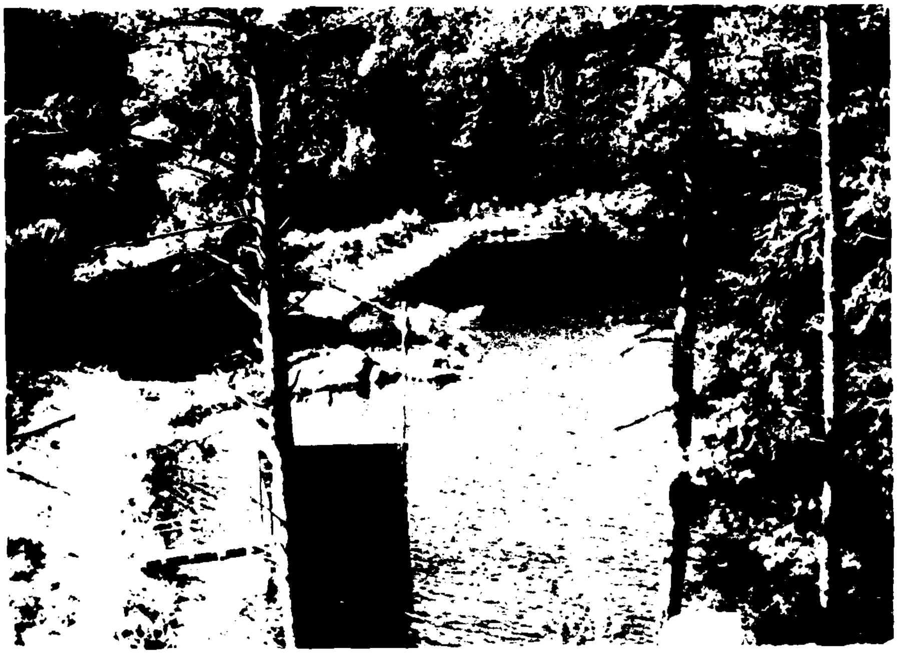


Photo No. 2 - General view of dam from left abutment.

Photo No. 5 - View of crest of right section of dam and right abutment from center of dam.

Photo No. 6 - View of crest of right section of dam from right abutment.

Photo No. 9 - Closeup view of intake structure at right abutment.

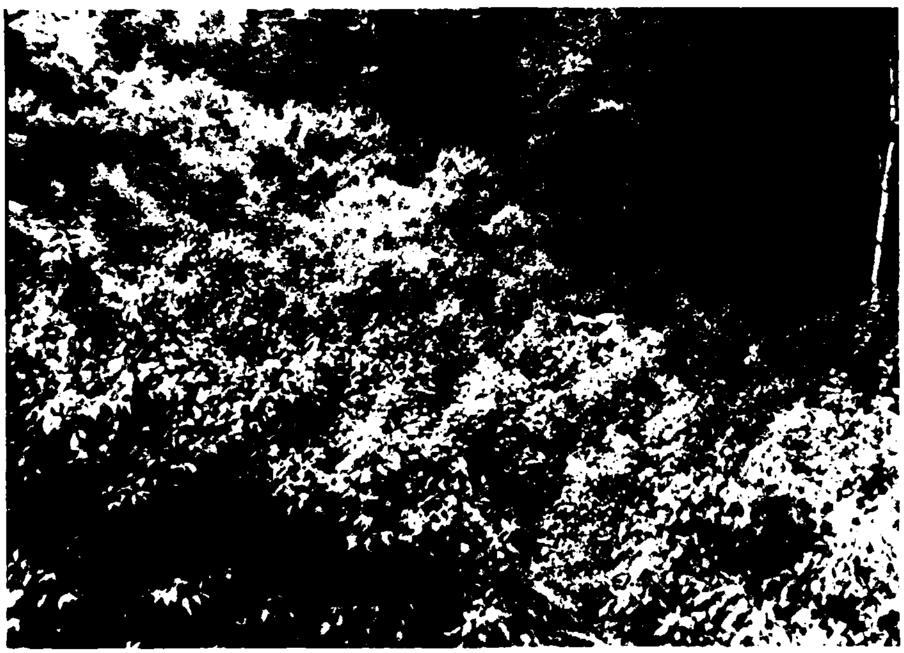


Photo No. 10 - Downstream face of right section of dam from right abutment.

Photo No. 13 - View of downstream channel from toe of right section of dam.

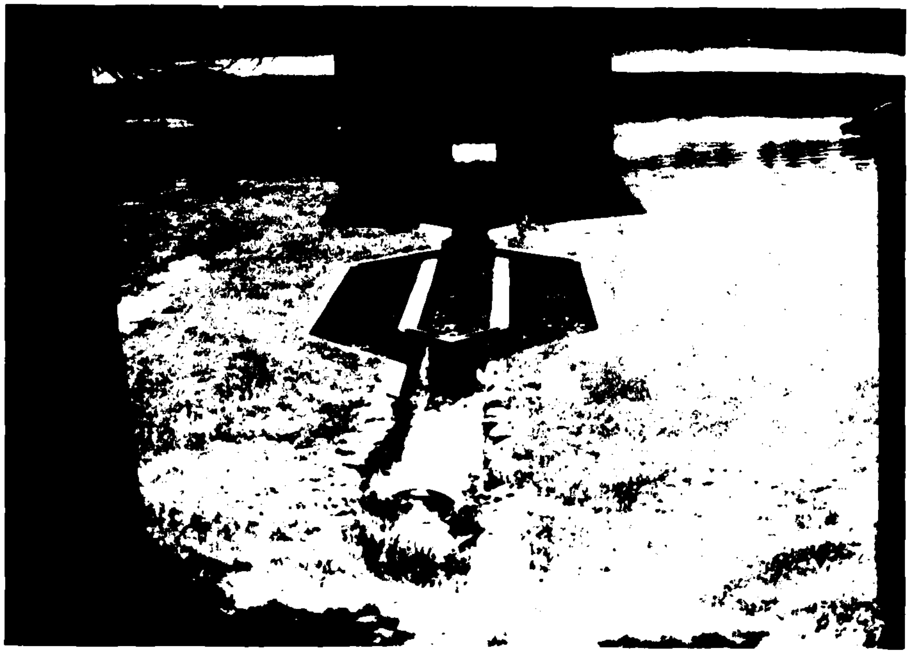


Photo No. 14 - View of concrete walled sluiceway and piped inflow near spillway at west end of reservoir.

APPENDIX D
HYDROLOGIC AND HYDRAULIC COMPUTATIONS

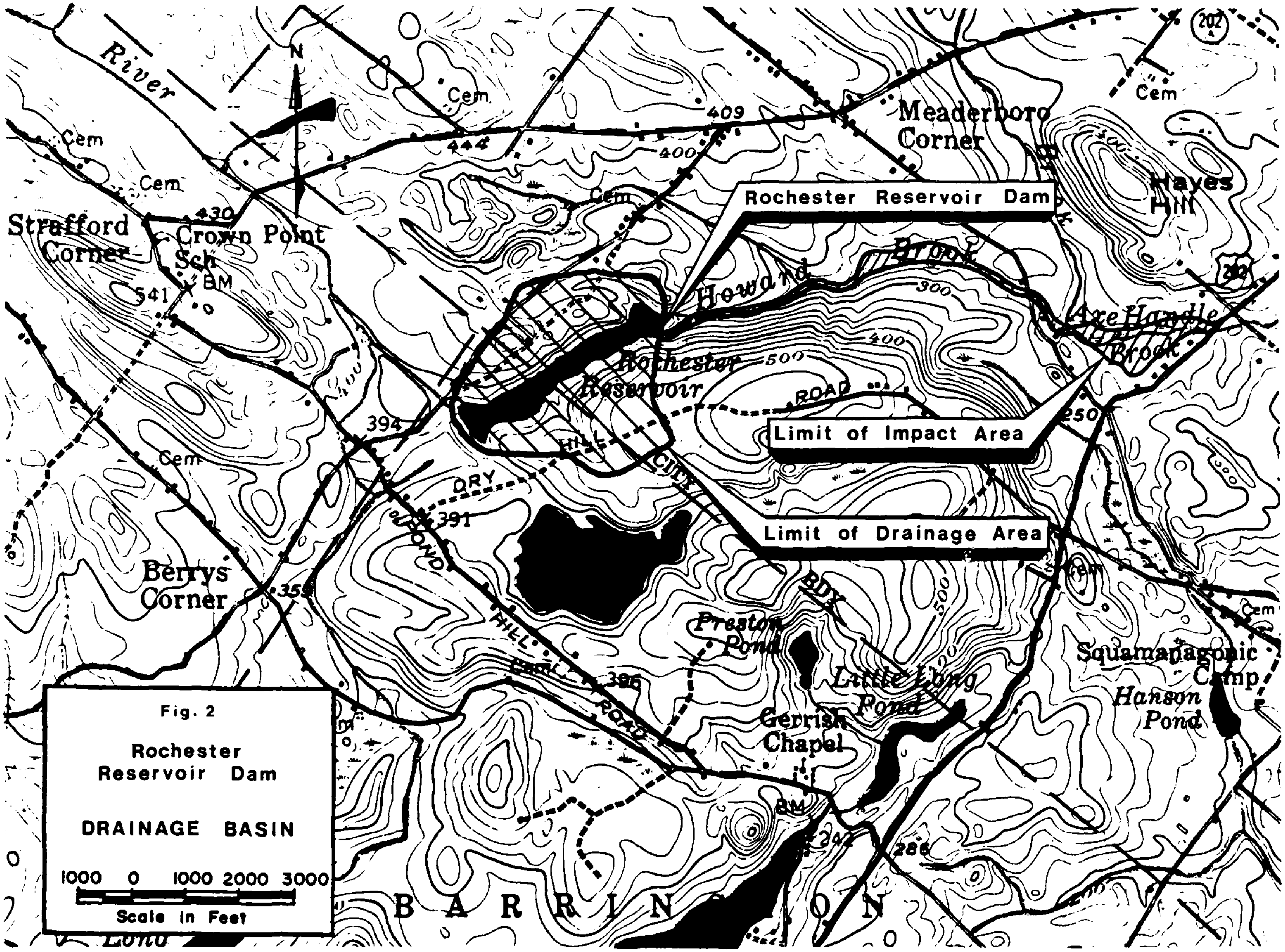


Fig. 2

Rochester Reservoir Dam

DRAINAGE BASIN

S|E|A CONSULTANTS INC.
ENGINEERS / PLANNERS

BOSTON, MASS.
ROCHESTER, N.H.

CLIENT Army Corps — JOB NO. 2=4-7901 —
PROJECT Rochester Reservoir Dam — COMPTD. BY ?wP — DATE 6/24/90
DETAIL Hydrologic Calcs — CK'D. BY KMS — DATE 7/2/90

I. Basic Data

A. Drainage Area

1. ≈ 0.41 square miles – as defined on U.S.G.S. Sheet and then planimetered

2. drainage area would classify as rolling for estimating PMF Peak Flow Rates

B. Dam and Storage Information

1. Size Classification: SMALL based on either height (≥ 25 feet and < 40 feet) or storage (≥ 50 acre-ft and < 1000 acre-ft)

a height measured from toe to crest of dam ≈ 26 feet
b. storage at crest of dam ≈ 790 acre-feet

2. Hazard Potential: SIGNIFICANT

3. Storage Information

Descriptive Information	Elevation* feet (NGVD)	Surface Area* acres	Storage* acre-feet
380' Contour	380.0	90	
Crest of dam	377.0	70	790
Normal Pool (Spillway crest elev.)	375.0	56	550

* Notes : (1) elevations : NGVD

(2) Spillway crest elevation taken to correspond with pool elevation of 375 feet shown on USGS sheet

(3) Surface area at normal pool elev. taken to correspond with pool shown on U.S.G.S Sheet

(4) Storage at normal pool was determined by dividing the pond into a series of pyramidal frustrums and computing the volume of each frustrum in order to determine the total volume of the pond.

C. Spillway Information

1. The principal spillway is located at the extreme west end of the reservoir

a. Spillway consists of a concrete slab which measures 19.5 feet between low concrete walls. Crest of spillway set at an elevation of 375 ft (NGVD)

b. Discharge over spillway may be determined with the broad-crested weir equation

(1) $Q = CLH^{3/2}$ (Standard Handbook for CE's, Merritt)

where : Q = discharge, cfs
C = discharge coeff. ≈ 2.7
L = length of weir, feet
H = head over weir, feet

II. Estimate Effect of Surcharge Storage on 1/2 Maximum Probable Discharge

A. Develop stage-discharge curve for outflow from dam - spillway complex

1. define sources of outflow

a. discharge over spillway - above elevation 375 as defined above

b. discharge over spillway abutments using broad-crested weir equation with C = 2.6 (above elevation 375.5)

c. discharge over dam crest and abutments using broad-crested weir equation with C = 2.6 (above elevation 377.0)

d. Water leaving reservoir through pipes feeding distribution system essentially equivalent to water entering reservoir through pipes from Round Pond and Berrys River. Therefore, these sources of inflow and outflow will not impact surcharge storage analysis

2. Discharge over spillway

Elevation feet (NGVD)	C	L feet	H feet	Q cfs
375.0	—	19.5	0	0
375.5	2.7	↓	0.5	20
376.0	↓	↓	1.0	50
376.5	↓	↓	1.5	100
377.0	↓	↓	2.0	150
377.5	↓	↓	2.5	210
378.0	↓	↓	3.0	275

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ENGINEERS / PLANNERS

BOSTON, MASS.
ROCHESTER, N.H.

CLIENT	Army Corps	JOB NO.	274-7901	PAGE	4 of 27
PROJECT	Rochester Reservoir Dam	COMPTD. BY	BWP	DATE	6/25/90
DETAIL	Hydrologic Calcs	CK'D. BY	KMS	DATE	7/2/90

3. Discharge over spillway abutments

a. Portion of left abutment adjacent to spillway

Elevation feet (NGVD)	C	L feet	Avg H feet	Q cfs
375.5	—	0	0	0
376.0	2.6	45	0.25	15
376.5			0.75	75
377.0			1.25	165
377.5			1.75	270
378.0			2.25	395

b. Remainder of left abutment

Elevation feet (NGVD)	C	L feet	Avg H feet	Q cfs
376.0	—	0	0	0
376.5	2.6	8	0.25	< 5
377.0		16	0.5	15
377.5		24	0.75	40
378.0		32	1.0	95

c. Right abutment

Elevation feet (NGVD)	C	L feet	Avg H feet	Q cfs
375.5	—	0	0	0
376.0	2.6	28	0.25	10
376.5		54	0.5	50
377.0		80	0.75	135
377.5		106	1.0	275
378.0		132	1.25	450

4. Discharge over dam

a. over right portion of dam

Elevation feet (NGVD)	C	L feet	Avg. H feet	Q cfs
377.0	—	0	0	0
377.5	2.6	215	0.25	70
380.0	2.6	340	0.5	310

b. over left portion of dam

Elevation feet (NGVD)	C	L feet	Avg. H feet	Q cfs
377.1	—	0	0	0
377.5	2.6	90	0.2	20
380.0	2.6	160	0.45	125

5. Total discharge from dam-spillway complex

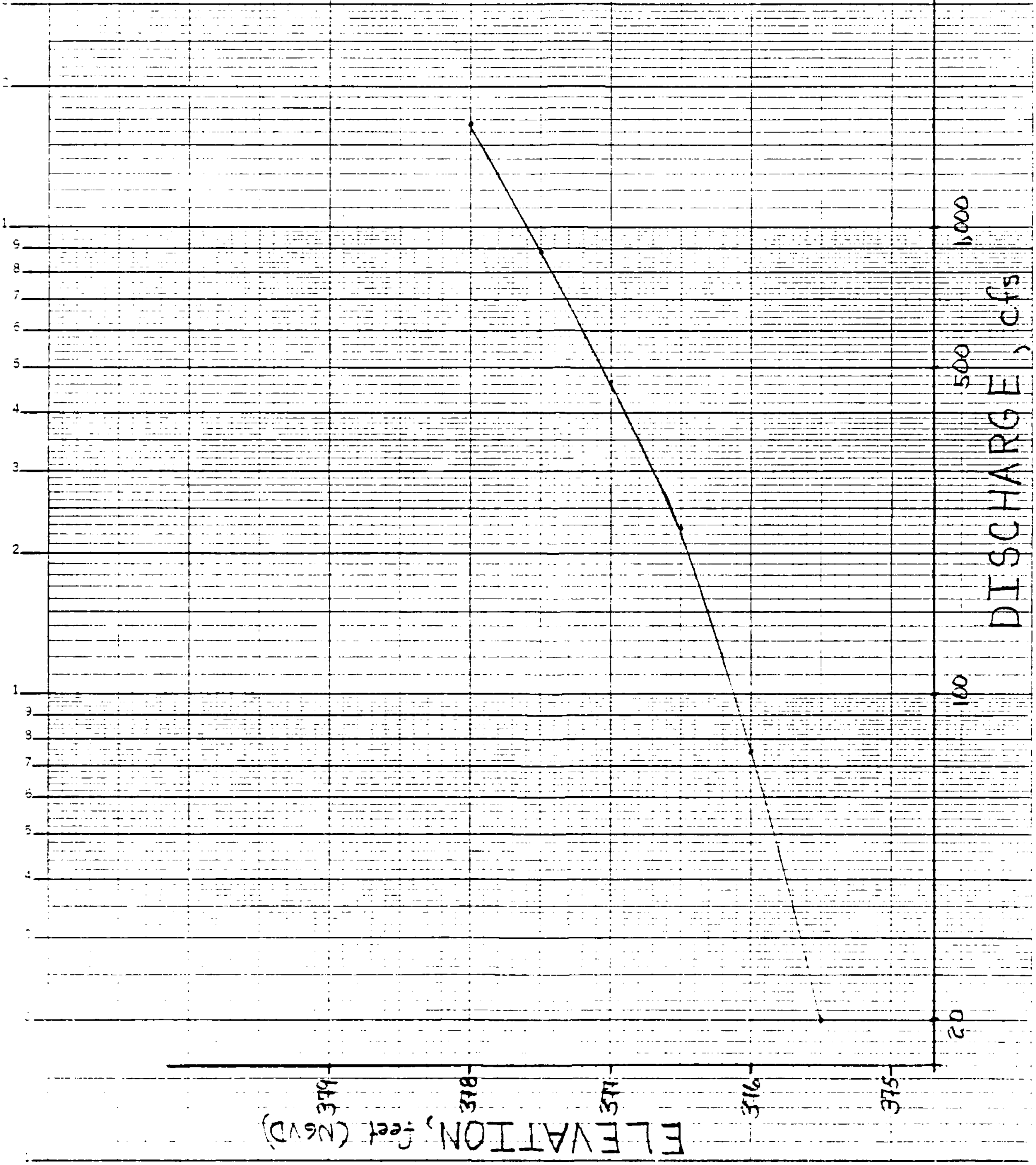
Elevation feet (NGVD)	Q Spillway	Q Spillway left abut	Q Spillway left abut.	Q Spillway right abut	Q dam, right portion	Q dam, left portion	Q TOTAL
375.0	0	0	0	0	0	0	0
375.5	20	0	0	0	0	0	20
376.0	50	15	0	10	0	0	75
376.5	100	75	45	50	0	0	225
377.0	150	165	15	135	0	0	465
377.5	200	270	40	275	70	20	895
378.0	275	395	95	450	310	125	1,670

Discharge vs Elevation summarized graphically in Figure 1

Rochester Reservoir Dam   Job No. 224-7901   6/25/80   JMS

FIGURE 1

DISCHARGE vs ELEVATION



D. Reach 4

1. STEP 3: Prepare stage-discharge curve for Reach

   a. Pertinent Data

      (1) Reach length = 1,500 feet
      (2) Channel slope = 0.0045
      (3) Manning n = 0.06
      (4) Channel shape - trapezoidal (side slopes not constant, compute x-area second [illegible]
      (5) Base width ≈ 10 feet

   b. See Figure 3 for stage-discharge curve

2. STEP 4: Estimate Reach Outflow

   a. Determine stage for Q_{P4} = 15,200 cfs from Figure 3 and find volume in reach

      (1) Stage (depth of flow) = 7.6 feet

      (2) Volume in reach = (reach length) (cross-sectional area of channel)

$$\text{X-area} = 1090\ ft^2 + (0.5)(3.6\ ft)(525\ ft + 575 \ldots$$
$$= 3070\ ft^2$$

$$\text{Volume} = V_1 = \frac{(3070\ ft^2)(1500\ ft)}{43{,}560\ ft^2/acre}$$

$$= 106 \text{ acre-feet}$$

$V_1 < \frac{S}{2}$ ∴ reach length OK

   b. Determine $Q_{P5(TRIAL)}$

$$Q_{P5(TRIAL)} = Q_{P4}\left(1 - \frac{V_1}{S}\right)$$

$$Q_{P5(TRIAL)} = (15{,}200\text{ cfs})\left(1 - \frac{106}{740}\right)$$

$$Q_{P5(TRIAL)} \approx 13{,}200\text{ cfs}$$

c. Compute V_2 using $Q_{P4(TRIAL)}$

From Figure 3 determine stage for $Q_{P4(TRIAL)}$

Stage = 13.3 feet

X-area = $460\ ft^2 + (0.5)(7.3\ ft)(210 + 335$
$\approx 2449\ ft^2$

$$V_2 = \frac{(2449\ ft^2)(1300\ ft)}{43{,}560\ ft^2/acre}$$

V_2 = 73.1 acre-ft

d. Average V_1 and V_2 and compute Q_{P4}

(1) $Vavg = \frac{V_1 + V_2}{2}$

$$V_{avg} = \frac{78.3\ ac\text{-}ft + 73.1\ ac\text{-}ft}{2}$$

Vavg = 75.7 acre-ft

(2) $Q_{P4} = Q_{P3}\left(1 - \frac{Vavg}{S}\right)$

$$Q_{P4} = (16{,}800\ cfs)\left(1 - \frac{75.7}{790}\right)$$

Q_{P4} = 15,200 cfs

C. Reach 3

1. STEP 3: Prepare stage-discharge curve for Reach 3

a. Pertinent Data

(1) Reach length = 1,300 feet
(2) Channel slope = 0.0045
(3) Manning n = 0.06
(4) Channel shape - trapezoidal (side slopes not consistent compute X-area accordingly)
(5) Base width ≈ 10 feet

b. See Figure 3 for stage-discharge curve

2. STEP 4: Estimate Reach Outflow

a. Determine stage for Q_{P3} = 16,800 cfs from Figure 3 and find volume in reach

(1) Stage (depth of flow) = 13.8 feet

(2) Volume in reach = (reach length) $\begin{pmatrix}\text{cross-sectional}\\ \text{area of channel}\end{pmatrix}$

$$\text{X-area} = 460 \text{ ft}^2 + (0.5)(7.8 \text{ ft})(210 \text{ ft} + 345 \text{ ft})$$
$$\approx 2625 \text{ ft}^2$$

$$\text{Volume} = V_1 = \frac{(2625 \text{ ft}^2)(1300 \text{ ft})}{43{,}560 \text{ ft}^2/\text{acre}}$$

$$= 78.3 \text{ acre-ft}$$

$V_1 < \frac{S}{2}$ ∴ reach length OK

b. Determine $Q_{P4(TRIAL)}$

$$Q_{P4(TRIAL)} = Q_{P3}\left(1 - \frac{V_1}{S}\right)$$

$$Q_{P4(TRIAL)} = (16{,}800 \text{ cfs})\left(1 - \frac{78.3}{790}\right)$$

$$Q_{P4(TRIAL)} = 15{,}100 \text{ cfs}$$

c. Compute V_2 using $Q_{P3(TRIAL)}$

From Figure 3 determine stage for $Q_{P3(TRIAL)}$

Stage = 10.0 feet

X-area = $460\ ft^2 + (0.5)(4.0\ ft)(210\ ft + 280\ ft)$

$\approx 1440\ ft^2$

$$V_2 = \frac{(1440\ ft^2)(1600\ ft)}{43{,}560\ ft^2/acre}$$

$V_2 = 52.9$ acre-ft

d. Average V_1 and V_2 and compute Q_{P3}

(1) $$V_{avg} = \frac{V_1 + V_2}{2}$$

$$V_{avg} = \frac{56.0\ ac\text{-}ft + 52.9\ ac\text{-}ft}{2}$$

$V_{avg} = 54.5$ acre-ft

(2) $$Q_{P3} = Q_{P2}\left(1 - \frac{V_{avg}}{S}\right)$$

$$Q_{P3} = (18{,}000\ cfs)\left(1 - \frac{54.5}{790}\right)$$

$Q_{P3} \approx 16{,}800$ cfs

B. Reach 2

1. STEP 3: Prepare stage-discharge curve for Reach 2

a. Pertinent Data

(1) Reach length = 1,600 feet

(2) Channel slope = 0.025

(3) Manning n = 0.06

(4) Channel shape - trapezoidal (Side slopes not constant compute X-area accordingly)

(5) Base width ≈ 10 feet

b. See Figure 3 for stage-discharge curve

2. STEP 4: Estimate Reach Outflow

a. Determine stage for Q_{P2} = 18,000 cfs from Figure 3 and find volume in reach

(1) Stage (depth of flow) = 10.3 feet

(2) Volume in reach = (reach length) $\begin{pmatrix}\text{cross-sectional}\\ \text{area of channel}\end{pmatrix}$

$$\text{X-area} = 460\ ft^2 + (0.5)(4.3\ ft)(210\ ft + 235\ ft) = 1524\ ft^2$$

$$\text{Volume} = V_1 = \frac{(1524\ ft^2)(1{,}600\ ft)}{43{,}560\ ft^2/acre}$$

$$= 56.0\ \text{acre-ft}$$

$V_1 < \frac{S}{2}$ ∴ reach length OK

b. Determine $Q_{P3(TRIAL)}$

$$Q_{P3(TRIAL)} = Q_{P2}\left(1 - \frac{V_1}{S}\right)$$

$$Q_{P3(TRIAL)} = (18{,}000\ cfs)\left(1 - \frac{56.0}{770}\right)$$

$$Q_{P3(TRIAL)} \approx 16{,}700\ cfs$$

c. Compute V_2 using $Q_{P2(TRIAL)}$

From Figure 3 determine stage for $Q_{P2(TRIAL)}$

Stage = 9.4 feet

X-area = $460 \text{ ft}^2 + (0.5)(3.4 \text{ ft})(210 \text{ ft} + 270 \text{ ft})$

$\approx 1276 \text{ ft}^2$

$$V_2 = \frac{(1276 \text{ ft}^2)(1{,}200 \text{ ft})}{43{,}560 \text{ ft}^2/\text{acre}}$$

$V_2 = 35.1$ acre-ft

d. Average V_1 and V_2 and compute Q_{PZ}

(1) $\text{Vavg} = \dfrac{V_1 + V_2}{2}$

$$V_{avg} = \frac{36.7 \text{ ac-ft} + 35.1 \text{ acre-ft}}{2}$$

Vavg = 35.9 acre-feet

(2) $Q_{PZ} = Q_{P1}\left(1 - \frac{\text{Vavg}}{S}\right)$

$$Q_{PZ} = (18{,}900 \text{ cfs})\left(1 - \frac{35.9}{790}\right)$$

$Q_{PZ} \approx 18{,}000$ cfs

3. STEP 3: Prepare stage-discharge curve for Reach 1

a. Pertinent Data

(1) Reach length = 1,200 feet
(2) Channel slope = 0.042
(3) Manning n = 0.06
(4) Channel shape - trapezoidal (side slopes not consistent / compute x-area accordingly)
(5) Base width ≈ 10 feet

b. See Figure 3 for stage-discharge curve

4. STEP 4: Estimate Reach Outflow

a. Determine stage for Q_{P_1} = 18,900 cfs from Figure 3 and find volume in reach

(1) Stage (depth of flow) = 9.6 feet

(2) Volume in reach = (reach length) (cross-sectional area of channel)

$$\text{X-area} = 460\ \text{ft}^2 + (0.5)(3.6\ \text{ft})(210\ \text{ft} + 275\ \text{ft})$$
$$= 1333\ \text{ft}^2$$

$$\text{Volume} = V_1 = \frac{(1333\ \text{ft}^2)(1200\ \text{ft})}{43{,}560\ \text{ft}^2/\text{acre}}$$

$$= 36.7\ \text{acre-feet}$$

$$V_1 < \frac{S}{2} \quad \therefore \text{reach length OK}$$

b. Determine $Q_{P2(TRIAL)}$

$$Q_{P2(TRIAL)} = Q_{P1}\left(1 - \frac{V_1}{S}\right)$$

$$Q_{P2(TRIAL)} = (18{,}900\ \text{cfs})\left(1 - \frac{36.7\ \text{ac-ft}}{790\ \text{ac-ft}}\right)$$

$$Q_{P2(TRIAL)} \approx 18{,}000\ \text{cfs}$$

III. Using "Rule of Thumb" Guidance for Estimating Downstream Dam Failure Hydrographs examine impact of dam failure

1. Pertinent Data

a. Failure occurs when reservoir level at crest of dam - elevation = 377.0 feet (NGVD)

b. Storage at crest elevation estimated to be approximately 790 acre-feet

A. Reach 1

1. STEP 1: Determine reservoir storage at time of failure

from previous calcs. storage = 790 acre-feet

2. STEP 2: Determine Peak Failure Outflow Q_{P1}

$$Q_{P1} = (8/27)\, W_b \sqrt{g}\, Y_o^{3/2}$$

where: W_b = Breach width (use 40% of mid-height length of right section)
= (292 feet) (0.4)
≈ 117 feet - assumes portion of right section fails, since this will produce the worst failure situation

Y_o = Total height from channel bed to pool level at failure
≈ 21 feet - max height of right section

$$Q_{P1} = (8/27)(117\text{ feet})(32.2)^{1/2}(21\text{ feet})^{1.5}$$

$$Q_{P1} \approx 18{,}900 \text{ cfs}$$

$STOR_4$ and $STOR_{AVG}$ agree to within about 2%, therefore accept routed test flood outflow equal to 267 cfs at a surcharge elevation of 376.6 feet

7. In Conclusion

a. The Routed Test Flood Outflow ≈ 265 cfs will **NOT** overtop the dam

b. spillway capacity

(1) water surface at crest of dam - elev = 377.0 ft

(a) discharge between training walls

$$Q = (2.7)(19.5\ ft)(377.0' - 375.0')^{3/2} \approx 150 cfs$$

(b) between training walls + over spillway abutments, from Figure 1 ≈ 465 cfs

(2) water surface at test flood elevation = 376.6 ft

(a) discharge between training walls

$$Q = (2.7)(19.5\ ft)(376.6' - 375.0')^{3/2} \approx 105 cfs$$

(b) between training walls + over spillway abutments from Figure 1 ≈ 265 cfs

c. blowoff capacities using orifice discharge equation

(1) below gate house

$$Q = (0.6)\left[(0.25)^2 \pi\right]\left[(2)(32.2)(377.0 - 345.75)\right]^{1/2} \approx 5 cfs$$

(2) at right abutment

$$Q = (0.6)\left[(0.25)^2 \pi\right]\left[(2)(32.2)(377.0' - 364.05')\right]^{1/2} \approx 3 cfs$$

$STOR_3$ = 4.51 inches

c. determine $STOR_{AVG}$

$$STOR_{AVG} = \frac{4.91 \text{ in} + 4.51 \text{ in}}{2}$$

$$STOR_{AVG} = 4.71 \text{ inches}$$

d. determine Q_{P4}

$$Q_{P4} = (530 \text{ cfs})\left(1 - \frac{4.71''}{9.5''}\right)$$

$$Q_{P4} = 267 \text{ cfs}$$

6. STEP 5: Determine surcharge height for Q_{P4} and $STOR_4$

a. From Figure 1 surcharge height for $Q_{P4} \approx 265$ cfs

Surcharge elevation ≈ 376.6 ft
Crest of spillway = 375.0 ft
Surcharge height = 1.6 feet

Pond surface area @ surcharge elevation ≈ 67 acres

b. determine $STOR_4$

$$STOR_4 = \frac{\left[\left(\frac{56 ac + 67 ac}{2}\right)(1.6 ft)\right](12''/ft)}{262 \text{ acres}}$$

$$STOR_4 = 4.51 \text{ inches}$$

c. determine $STOR_{AVG}$

$$STOR_{AVG} = \frac{4.71 \text{ in} + 4.51 \text{ in}}{2}$$

$$= 4.61 \text{ inches}$$

b. determine $STOR_2$

$$STOR_2 = \frac{\left[\left(\frac{56ac. + 60.5ac}{2}\right)(1.4\,ft)\right](12''/ft)}{262\,acres}$$

$$= 3.74\text{ inches}$$

c. Average $STOR_1$ and $STOR_2$

$$STOR_{AVG} = \frac{STOR_1 + STOR_2}{2}$$

$$STOR_{AVG} = \frac{6.08\text{ in.} + 3.74\text{ in.}}{2}$$

$$STOR_{AVG} = 4.91\text{ inches}$$

d. determine Q_{P3}

$$Q_P = (530\,cfs)\left(1 - \frac{4.91''}{9.5''}\right)$$

$$Q_P \approx 255\,cfs$$

5. STEP 4. determine surcharge height for Q_{P3} and $STOR_3$

a. from figure 1 surcharge height for $Q_{P3} \approx 255\,cfs$

surcharge elevation ≈ 376.6 ft
crest of spillway = 375.0 ft
surcharge height = 1.6 ft

pond surface area @ surcharge elev. ≈ 67 acres

b. determine $STOR_3$

$$STOR_3 = \frac{\left[\left(\frac{56\,ac + 67\,ac}{2}\right)(1.6\,ft)\right](12''/ft)}{262\,acres}$$

(3) multiply average surface area by surcharge height, inserting appropriate values in the following equation

$$STOR_1 = \frac{\text{Volume of storage (in acre-inches)}}{\text{drainage area}}$$

$$STOR_1 = \frac{\left[\left(\frac{56 \text{ acres} + 70.5 \text{ acres}}{2}\right)(2.1 \text{ ft})\right](12''/\text{ft})}{262 \text{ acres}}$$

$$STOR_1 = 6.08 \text{ inches}$$

c. determine Q_{P2}

$$Q_{P2} = Q_{P1}\left(1 - \frac{STOR}{9.5''}\right)$$

$$Q_{P2} = (530 \text{ cfs})\left(1 - \frac{6.08''}{9.5''}\right)$$

$$Q_{P2} \approx 190 \text{ cfs}$$

4. STEP 3: Determine surcharge height and $STOR_2$ to pass Q_{P2} and then Q_{P3}

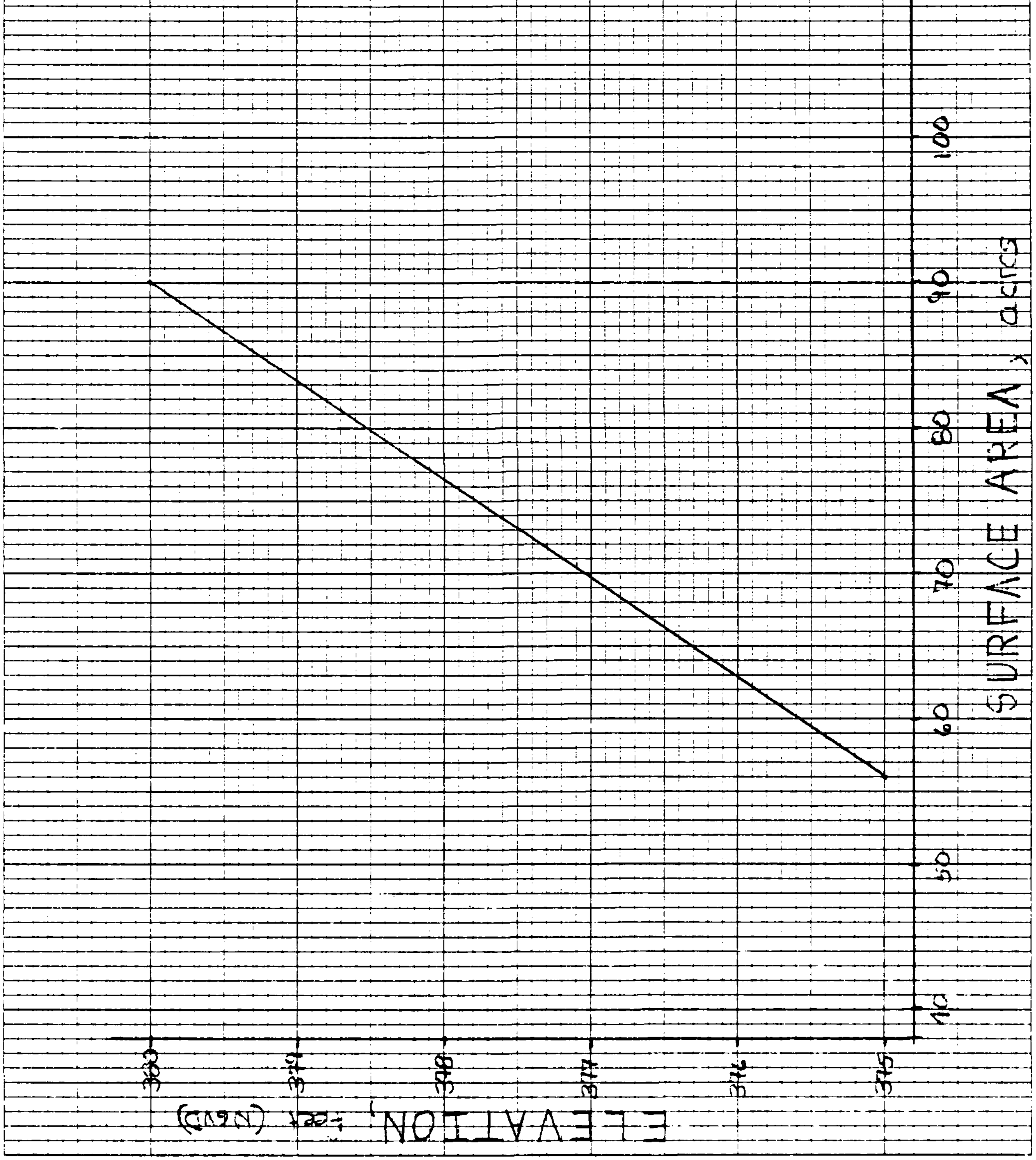
a. From Figure 1 determine surcharge height to pass $Q_{P2} \approx 190$ cfs

surcharge elevation ≈ 376.4 ft
crest of spillway = 375.0 ft
surcharge height = 1.4 feet

Pond surface area @ surcharge elevation ≈ 65.5 acres

FIGURE 2

SURFACE AREA vs. ELEVATION



B. Effect of surcharge storage on ½ max. prob. discharge

1. Pertinent Data

   a. Drainage area = 262 acres
   b. Characteristics of basin: moderately sloped terrain, use "rolling" curve
   c. Test flood = ½ PMF
   d. Follow Army Corps' procedure

2. STEP 1: Determine Peak Inflow Q_{P1} from Guide Curve

   a. the maximum probable discharge was estimated to be 2,600 cfs/sq.mi.

$$\therefore \text{PMF} = (262\text{ acres})(1\text{ sq.mi}/640\text{ acres})(2{,}600\text{ cfs/sq.mi.})$$

$$\approx 1{,}060\text{ cfs}$$

$$\tfrac{1}{2}\text{ PMF} = 530\text{ cfs}$$

3. STEP 2: Determine surcharge height to pass Q_{P1} (Q_{P1}) and Q_{P2}

   a. from Figure 1 determine surcharge height for Q_{P1} = 530 cfs

Surcharge elevation ≈ 377.1 ft
Crest of spillway = 375.0 ft
Surcharge height = 2.1 feet

   b. determine volume of surcharge STOR in inches of runoff

first determine volume of surcharge in acre-feet

(1) determine surface area of pond corresponding to surcharge elevation from Figure 2 ≈ 70.5 acres

(2) determine average surface area between surcharge elevation and crest of spillway

c. Compute V_2 using $Q_{P5(TRIAL)}$

From Figure 3 determine stage for $Q_{P5(TRIAL)}$

Stage = 7.1 feet

X-area = $1090\ ft^2 + (0.5)(3.1 ft)(525 ft + 565 ft)$
$\approx 2780\ ft^2$

$$V_2 = \frac{(2780\ ft^2)(1500\ ft)}{43{,}560\ ft^2/acre}$$

V_2 = 95.7 acre-ft

d. Average V_1 and V_2 and compute Q_{P5}

(1) $V_{avg} = \dfrac{V_1 + V_2}{2}$

$$V_{avg} = \frac{106\ ac\text{-}ft + 95.7\ acre\text{-}ft}{2}$$

$V_{avg} \approx$ 101 acre-feet

(2) $Q_{P5} = Q_{P4}\left(1 - \dfrac{V_{avg}}{S}\right)$

$$Q_{P5} = (15{,}200\ cfs)\left(1 - \frac{101}{790}\right)$$

$Q_{P5} \approx 13{,}300$ cfs

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BOSTON, MASS.
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CLIENT Army Corps
PROJECT Rochester Reservoir Dam
DETAIL Hydrologic Calcs.
JOB NO. 2?4-7901
COMPTD. BY BWP
CK'D. BY KMS

DATE 7/29/80
DATE 7/29/80

E. Reach 5

1. STEP 3: Prepare stage-discharge curve for Reach 5

   a. Pertinent Data

      (1) Reach length = 2,200 feet

      (2) Channel slope = 0.0045

      (3) Manning n = 0.06

      (4) Channel shape - trapezoidal (side slopes not consistent. Compute X-area accordingly.)

      (5) Base width ≈ 10 feet

   b. See Figure 3 for stage-discharge curve

2. STEP 4: Estimate Reach Outflow

   a. Determine stage for Q_{P5} = 13,300 cfs from Figure 3 and find volume in reach

      (1) Stage (depth of flow) = 15.8 feet

      (2) Volume in reach = (reach length) (cross-sectional area of channel)

$$\text{X-area} = 20\,ft^2 + (0.5)(13.8\,ft)(10\,ft + 305\,ft)$$
$$= 2{,}194\,ft^2$$

$$\text{Volume} = V_1 = \frac{(2{,}194\,ft^2)(2200\,ft)}{43{,}560\,ft^2/acre}$$

$$= 111 \text{ acre-feet}$$

$$V_1 < \frac{S}{2} \quad \therefore \text{reach length OK}$$

   b. Determine $Q_{P6(TRIAL)}$

$$Q_{P6(TRIAL)} = Q_{P5}\left(1 - \frac{V_1}{S}\right)$$

$$Q_{P6(TRIAL)} = (13{,}300\text{ cfs})\left(1 - \frac{111}{790}\right)$$

$$Q_{P6(TRIAL)} = 11{,}400\text{ cfs}$$

c. Compute V_2 using $Q_{P6(TRIAL)}$

From Figure 3 determine stage for $Q_{P6(TRIAL)}$

Stage = 14.9 feet

X-area = $20\ ft^2 + (0.5)(12.9\ ft)(10\ ft + 290\ ft)$
$\approx 1955\ ft^2$

$$V_2 = \frac{(1955\ ft^2)(2{,}200\ ft)}{43{,}560\ ft^2/acre}$$

V_2 = 98.7 acre-ft

d. Average V_1 and V_2 and compute Q_{P6}

(1) $V_{avg} = \frac{V_1 + V_2}{2}$

$$V_{avg} = \frac{111\ ac\text{-}ft + 98.7\ ac\text{-}ft}{2}$$

$V_{avg} \approx$ 105 acre-ft

(2) $Q_{P6} = Q_{P5}\left(1 - \frac{V_{avg}}{S}\right)$

$$Q_{P6} = (13{,}300\ cfs)\left(1 - \frac{105}{790}\right)$$

$Q_{P6} \approx 11{,}500$ cfs

F. Reach 6

1. STEP 3: Prepare stage-discharge curve for Reach 6

   a. Pertinent Data

      (1) Reach length = 2,900 feet
      (2) Channel slope = 0.0045
      (3) Manning n = 0.06
      (4) Channel shape - trapezoidal (Side slopes not constant / Compute X-area accordingly)
      (5) Base width ≈ 20 feet

   b. See Figure 3 for stage-discharge curve

2. STEP 4: Estimate Reach Outflow

   a. Determine stage for Q_{P6} = 11,500 cfs from Figure 3 and find volume in reach

      (1) Stage (depth of flow) = 7.9 feet

      (2) Volume in reach = (reach length) (cross-sectional area of channel)

$$\text{X-area} = 40\,ft^2 + (0.5)(5.9)(20\,ft + 1080\,ft)$$
$$= 3285\,ft^2$$

$$\text{Volume} = V_1 = \frac{(3285\,ft^2)(2900\,ft)}{43{,}560\,ft^2/acre}$$
$$= 219\ \text{acre-ft}$$

$$V_1 < \frac{S}{2}\ \therefore \text{reach length OK}$$

   b. Determine $Q_{P7(TRIAL)}$

$$Q_{P7(TRIAL)} = Q_{P6}\left(1 - \frac{V_1}{S}\right)$$

$$Q_{P7(TRIAL)} = (11{,}500\,cfs)\left(1 - \frac{219}{790}\right)$$

$$Q_{P7(TRIAL)} = 8{,}310\ cfs$$

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CLIENT	Army Corps	JOB NO.	274-7901	PAGE	25 of 27
PROJECT	Pointer Reservoir Dam	COMPTD. BY	BWP	DATE	7/29/80
DETAIL	Hydrologic Calcs.	CK'D. BY	KMS	DATE	7/29/80

c. Compute V_2 using $Q_{P7(TRIAL)}$

From Figure 3 determine stage for $Q_{P7(TRIAL)}$

Stage = 7.2 feet

X-area = $40 \text{ ft}^2 + (0.5)(5.2 \text{ ft})(20 \text{ ft} + 955 \text{ ft})$
$\approx 2575 \text{ ft}^2$

$$V_2 = \frac{(2575 \text{ ft}^2)(2900 \text{ ft})}{43{,}560 \text{ ft}^2/\text{acre}}$$

V_2 = 171 acre feet

d. Average V_1 and V_2 and compute Q_{P7}

(1) $$V_{avg} = \frac{V_1 + V_2}{2}$$

$$V_{avg} = \frac{219 \text{ ac-ft} + 171 \text{ ac-ft}}{2}$$

V_{avg} = 195 acre-ft

(2) $$Q_{P7} = Q_{P6}\left(1 - \frac{V_{avg}}{S}\right)$$

$$Q_{P7} = (11{,}500 \text{ cfs})\left(1 - \frac{195}{790}\right)$$

Q_{P7} = 8,660 cfs

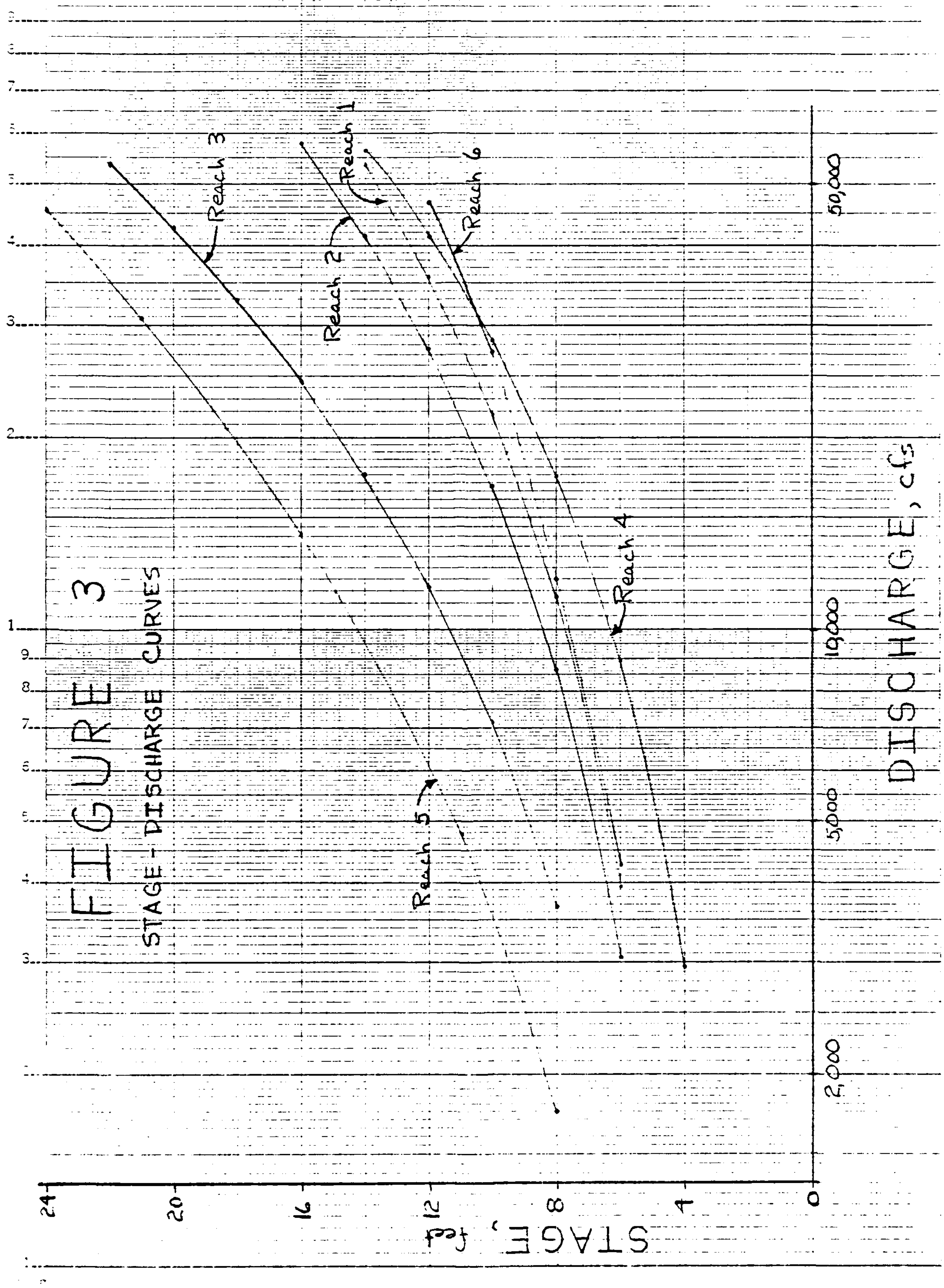
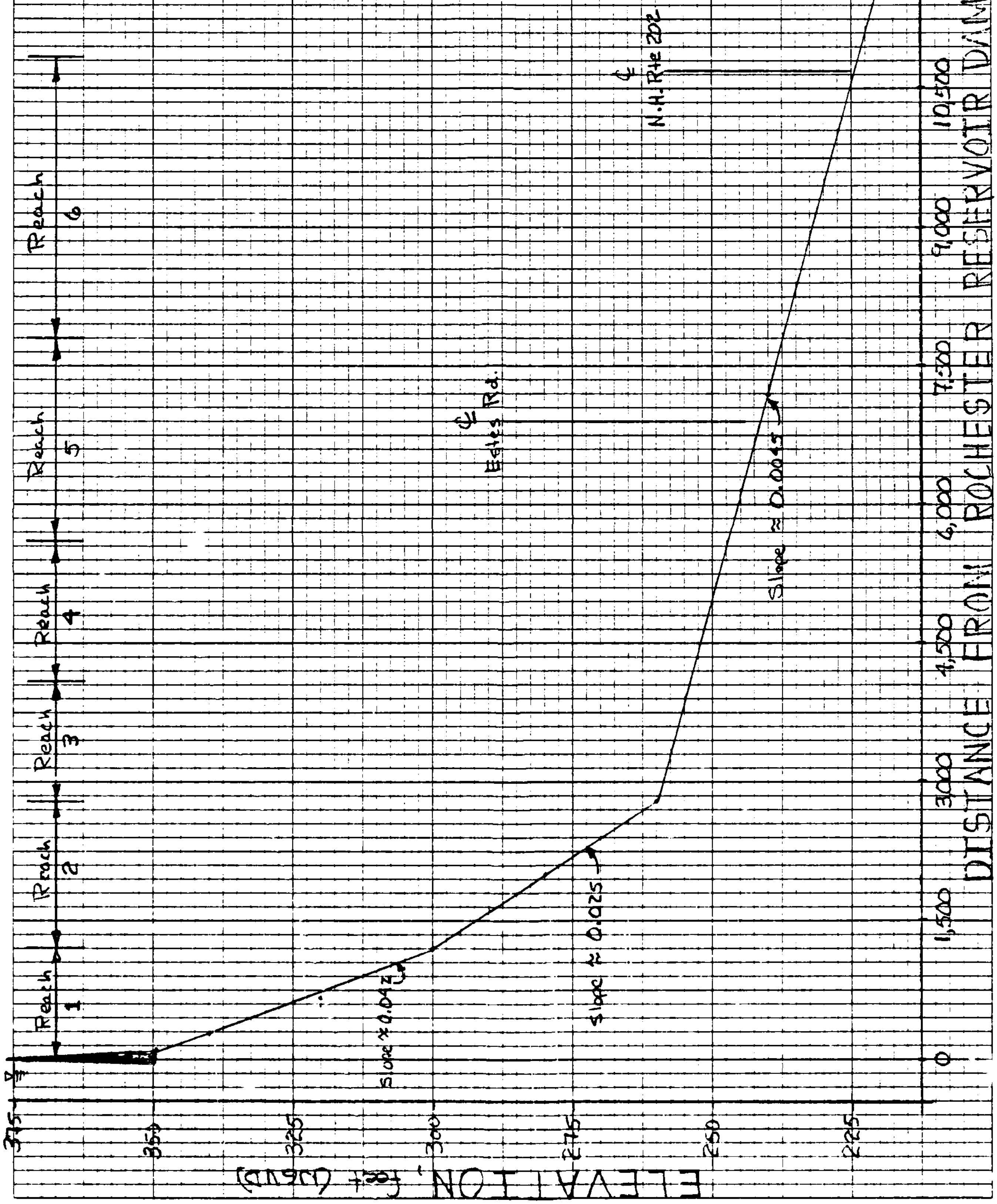


FIGURE 3
STAGE - DISCHARGE CURVES
Reach 1
Reach 2
Reach 3
Reach 4
Reach 5
Reach 6
DISCHARGE, cfs
50,000
10,000
5,000
2,000
STAGE, feet
24
20
16
12
8
4
0

Rochester Reservoir Dam   Job # 274-7901   BWF 6/20/80 KMS

FIGURE 4

DOWNSTREAM CHANNEL PROFILE



APPENDIX E

INFORMATION AS CONTAINED IN
THE NATIONAL INVENTORY OF DAMS

INVENTORY OF DAMS IN THE UNITED STATES

STATE	IDENTITY NUMBER	DIVISION	STATE	COUNTY	CONGR. DIST.	STATE	COUNTY	CONGR. DIST.	NAME	LATITUDE (NORTH)	LONGITUDE (WEST)	REPORT DATE DAY MO YR
NH	152	NED	NH	017	01				ROCHESTER RESERVOIR DAM	4317.3	7102.6	16JUL80

POPULAR NAME	NAME OF IMPOUNDMENT
	ROCHESTER RESERVOIR

REGION	BASIN	RIVER OR STREAM	NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	DIST FROM DAM (MI.)	POPULATION
01	06	HOWARD BROOK	ROCHESTER	3	20419

TYPE OF DAM	YEAR COMPLETED	PURPOSES	STRUCTURAL HEIGHT (FT.)	HYDRAULIC HEIGHT (FT.)	IMPOUNDING CAPACITIES MAXIMUM (ACRE-FT.)	NORMAL (ACRE-FT.)
PGRE	1900	S	26	26	790	665

DIST	OWN	FED R	PRV/FED	SCS A	VER/DATE
NED	N	N	N	N	

REMARKS
20-1977 STATE CENSUS 22-PRIOR

D/S HAS	SPILLWAY CREST LENGTH	TYPE	WIDTH (FT.)	MAXIMUM DISCHARGE (FT.)	VOLUME OF DAM (CY)	POWER CAPACITY INSTALLED (MW)	PROPOSED (MW)	NO.	NAVIGATION LOCKS LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)
2	668	U	20	150	21100											

OWNER	ENGINEERING BY	CONSTRUCTION BY
CITY OF ROCHESTER		

REGULATORY AGENCY DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NH WATER RES BOARD	NH WATER RES BOARD	NH WATER RES BOARD	NH WATER RES BOARD

INSPECTION BY	INSPECTION DATE DAY MO YR	AUTHORITY FOR INSPECTION
SEA CONSULTANTS INC	09JUN80	PL 92-367

REMARKS

END

FILMED

8-85

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